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Gender and age differences in antihypertensive drug use and blood pressure control

Antihipertansif ilaç kullanımı ve kan basıncı kontrolünde cinsiyet ve yaş farklılıkları

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Abstract

Aim: This study aimed to investigate the impact of gender on antihypertensive treatment patterns and blood pressure (BP) control in hypertensive patients.

Material and Methods: This retrospective study included 918 hypertensive patients (mean age: 56.5 ± 12.3 years; 530 men, 388 women) under antihypertensive treatment, including diuretics, beta blockers, calcium channel blockers (CCB), angiotensin converting enzyme inhibitor (ACEI), and angiotensin receptor blockers (ARB). BP control was defined as systolic and diastolic BP being <140/90 mmHg during the 6-month follow-up. Antihypertensive medications and BP control were compared between genders, and subgroup analyses were performed based on age groups.

Results: In the general population, BP control did not show a significant difference between genders. ACE inhibitors were prescribed more frequently to men (45.7% vs. 33.5%, $p < 0.001$), while women were more likely to receive monotherapy (24.2% vs. 19.6%, $p < 0.05$). Women showed better BP control with diuretics than men (46.6% vs. 34.1%, $p = 0.037$), and monotherapy was more effective in women than in men (38.3% vs. 23.1%, $p = 0.020$). Younger women (18–44 years) using calcium channel blockers (CCBs) demonstrated superior BP control compared to men in the same age group (41.2% vs. 31.3%, $p = 0.042$). Other antihypertensive drugs showed no significant gender- and age-related differences in their effect on BP control.

Conclusion: Gender-based differences were observed in antihypertensive treatment patterns and BP control. Women showed better BP control with monotherapy and specific drug classes like diuretics and CCBs in younger populations. These findings highlight the importance of gender-specific strategies in hypertension management to optimize outcomes.

Keywords: Antihypertensive drugs, blood pressure, gender, hypertension

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Öz

Amaç: Bu çalışma, hipertansif hastalarda antihipertansif tedavi modelleri ve kan basıncı (KB) kontrolü üzerindeki cinsiyet etkisini araştırmayı amaçlamıştır.

Gereç ve Yöntemler: Bu retrospektif çalışmaya, antihipertansif tedavi alan 918 hipertansif hasta (ortalama yaş: 56,5 ± 12,3 yıl; 530 erkek, 388 kadın) dahil edilmiştir. Tedavi, diüretikler, beta blokerler, kalsiyum kanal blokerleri (CCB), anjiyotensin dönüştürücü enzim inhibitörleri (ACEI) ve anjiyotensin reseptör blokerlerini (ARB) içerdi. Kan basıncı kontrolü, 6 aylık takip süresince sistolik ve diyastolik KB'nin <140/90 mmHg olması olarak tanımlandı. Antihipertansif ilaçlar ve kan basıncı kontrolü, cinsiyetler arasında karşılaştırılmış ve yaş gruplarına göre alt grup analizleri yapıldı.

Bulgular: Genel popülasyonda, BP kontrolü cinsiyetler arasında anlamlı bir fark göstermedi. ACE inhibitörleri erkeklere daha sık reçete edilirken (%45,7'ye karşı %33,5, p < 0,001), kadınların monoterapi alma olasılığı daha yüksekti (%24,2'ye karşı %19,6, p < 0,05). Kadınlar diüretiklerle erkeklerden daha iyi BP kontrolü gösterdi (%46,6'ya karşı %34,1, p = 0,037) ve monoterapi kadınlarda erkeklerden daha etkiliydi (%38,3'e karşı %23,1, p = 0,020). Kalsiyum kanal blokerleri (KKB) kullanan daha genç kadınlar (18-44 yaş), aynı yaş grubundaki erkeklere kıyasla üstün BP kontrolü gösterdi (%41,2'ye karşı %31,3, p = 0,042). Diğer antihipertansif ilaçlar BP kontrolü üzerindeki etkilerinde anlamlı cinsiyet ve yaşla ilgili farklılıklar göstermedi.

Sonuçlar: Antihipertansif tedavi modelleri ve KB kontrolü üzerinde cinsiyete dayalı farklılıklar gözlenmiştir. Kadınlar, monoterapi ve diüretikler veya genç yaş grubunda CCB gibi belirli ilaç sınıflarıyla daha iyi KB kontrolü sağlamıştır. Bu bulgular, hipertansiyon yönetiminde cinsiyete özgü stratejilerin benimsenmesinin sonuçları optimize etmek için önemini vurgulamaktadır.

Anahtar Kelimeler: Antihipertansif ilaçlar, cinsiyet, hipertansiyon, kan basıncı.

Introduction

Hypertension is one of the most prevalent cardiovascular risk factors globally and is considered a leading cause of both morbidity and mortality (1). Due to its asymptomatic nature, hypertension is often challenging to diagnose, yet its prevalence continues to rise, making it a persistent global health concern (2). Additionally, it is recognized as a significant risk factor for stroke, heart disease, and other cardiovascular conditions (3). Consequently, the prevention and effective management of hypertension are of critical importance for public health.

Despite the availability of antihypertensive treatments, many patients fail to achieve the target blood pressure levels (4). Current guidelines recommend a blood pressure target of less than 140/90 mm Hg in hypertensive patients (5). It is well-documented that the prevalence and control of hypertension vary according to factors such as age, sex, and patients characteristics (6, 7). Among these, gender emerges as a pivotal factor influencing both the pathophysiology of hypertension and the response to antihypertensive therapy. Hormonal differences and lifestyle factors contribute to significant variations in the development and treatment outcomes of hypertension between men and women (8).

Studies reveal that before menopause, men exhibit a higher prevalence of hypertension compared to women. However, following menopause, women experience a rapid increase in hypertension prevalence (9-11). This shift underscores the critical role of hormonal changes and associated physiological mechanisms (12). Furthermore, differences in adherence to antihypertensive medication and susceptibility to side effects are also observed between genders (7, 13). The latest hypertension guidelines highlight an increasing gender disparity in hypertension prevalence with advancing age (14, 15). Therefore, this study aimed to investigate the impact of gender on antihypertensive treatment patterns and blood pressure (BP) control in hypertensive patients.

Material and Methods

This retrospective study was conducted between January 2014 to December 2022 on hypertensive patients at the Cardiology Clinic of Dışkapı Yıldırım Beyazıt Training and Research Hospital. The study was approved by the Dışkapı Yıldırım Beyazıt Hospital's Ethics Committee (Date: 20.06.2022, Decision No: 140/15) and was carried out in accordance with the relevant ethical guidelines and the Helsinki Declaration (2013 Brazil revision). The need for informed consent was waived under the approval of the Local Ethics Committee due to the retrospective design.

To assess eligibility for the study, hypertensive patients on antihypertensive therapy were evaluated retrospectively. Inclusion criteria for the study were individuals over 18 years old with a diagnosis of hypertension who were receiving regular treatment and follow-up, patients who had started antihypertensive therapy and had been under treatment for at least six months, and patients with no missing data during the study. Exclusion criteria included patients with a diagnosis of secondary hypertension, pregnant or breastfeeding women, patients with any comorbid conditions, those with an unknown treatment history, and those with incomplete data records. After applying the exclusion criteria, 918 patients were included in the study.

The hospital's electronic information system and patient files were used to gather demographic and clinical data. Data from patient files were used to identify antihypertensive medications, which were then grouped into therapeutic classes, including diuretics, beta blockers, calcium channel blockers (CCB), angiotensin converting enzyme inhibitor (ACEI), and angiotensin receptor blockers (ARB). Monotherapy was defined as the use of only one class of antihypertensive drugs. The assessment of BP control was conducted retrospectively using BP levels from patients' records during a 6-month follow-up. It defined as pharmacological treatment of hypertension associated with an average systolic BP (SBP) <140 mm Hg or diastolic BP (DBP) <90 mm Hg (16).

Statistical analysis

All analyses were conducted using IBM SPSS Statistics for Windows 20.0 (IBM Corp., Armonk, NY, USA) software. The normal distribution of numerical variables was assessed using the Kolmogorov-Smirnov test. Data exhibiting a normal distribution were presented as mean ± standard deviation, and comparisons between groups were made using the Student's T-test. Non-normally distributed data were displayed as median (interquartile range (IQR): 25-75 percentiles) and comparisons between groups were conducted using the Mann-Whitney U test. Value of $P < 0.05$ were considered statistically significant.

Results

The study included 918 patients with a mean age of 56.5 ± 12.3 years, of whom 530 were men and 388 were women. The mean age was comparable between male and female (55.8 ± 12.3 vs. 57.0 ± 12.3, $p = 0.144$). While the mean BMI was higher in female than in male, there was no significant difference in obesity rates between the groups (55.8% vs. 52.1%, $p = 0.255$). At 6 months of follow-up, the mean SBP was 140.8 ± 13.5 mm Hg for males and 139.8 ± 13.8 mm Hg for females ($p > 0.05$), and the mean DBP was 82.3 ± 7.2 mm Hg and 83.8 ± 7.1 mm Hg, respectively ($p > 0.05$). Demographic and clinical characteristics of patients are shown in Tables 1.

The most commonly prescribed drug class was CCBs (51%), while diuretics were the least frequently prescribed (31.2%). ACEI use was more common in male compared to female (45.7% vs. 33.5%, $p < 0.001$), but there were no gender-based differences in the use of other medications. Additionally, 21.6% of the patients were receiving monotherapy, while the remaining patients were on combination therapy. Monotherapy was more commonly prescribed to female than male (24.2% vs. 19.6%, $p < 0.05$), while male were more frequently treated with three or more medications (23.0% vs. 16.5%, $p < 0.05$). In the general population, BP control did not show a significant difference between genders (Table 1).

Diuretic use in female was linked to higher BP control than in male (46.6% vs. 34.1%, $p = 0.037$), while other antihypertensive drugs showed no significant gender-related differences in their effect on BP control ($p > 0.05$). Blood pressure control was higher in women using antihypertensive monotherapy compared to men using similar monotherapy (38.3% vs. 23.1%, $p = 0.020$) (Table 2).

Female aged 18–44 using CCBs demonstrated better BP control compared to male in the same age group (41.2% vs. 31.3%, $p = 0.042$). However, this significance disappeared in other age groups ($p > 0.05$). The impact of other antihypertensive drugs on BP control was not significantly different between genders across all age groups (Table 3).

Discussion

This study aimed to evaluate the effects of gender differences on antihypertensive treatment response and blood pressure control in a cohort of 918 hypertensive patients. Key findings revealed that while there were some notable gender-based differences in treatment patterns and outcomes, overall BP control was not significantly different between men and women. These results highlight the importance of considering gender-specific factors when tailoring antihypertensive therapy.

The study population had a comparable mean age between males and females, aligning with previous findings that hypertension affects both genders across similar age ranges (17). The mechanisms underlying gender differences in BP control are not fully understood, but it is hypothesized that

Table 1. Demographic and clinical characteristics of patients.				
Variables	All population n = 918	Female n = 388	Male n = 530	P-value
Age, years	56.5 ± 12.3	55.8 ± 12.3	57.0 ± 12.3	0.144
18-44 years, n (%)	162 (17.6)	70 (17.9)	92 (17.4)	0.122
45-64 years, n (%)	458 (49.9)	206 (52.6)	252 (47.5)	
≥65 years, n (%)	298 (32.5)	112 (28.9)	186 (35.1)	
BMI, kg/m2	31.3 ± 5.3	33.2 ± 5.8	30.0 ± 4.9	0.001*
Obesity, n (%)	498 (54.2)	224 (57.3)	274 (51.7)	0.093
Smoking, n (%)	294 (32.0)	72 (18.6)	222 (41.9)	<0.001*
BP at 6-months				
SBP, mm Hg	140.4 ± 13.7	139.8 ± 13.8	140.8 ± 13.5	0.290
DBP, mm Hg	84.1 ± 7.2	83.8 ± 7.1	82.3 ± 7.2	0.273
Antihypertensive drug, n (%)				
CCB	468 (51.0)	214 (55.2)	254 (47.9)	0.068
ACEI	372 (40.5)	130 (33.5)	242 (45.7)	<0.001*
Diuretic	286 (31.2)	116 (29.9)	170 (32.1)	0.481
ARB	330 (35.9)	134 (34.5)	196 (37.0)	0.446
Beta blocker	390 (42.5)	154 (39.7)	236 (44.5)	0.143
Number of drugs,				
One	198 (21.6)	94 (24.2)	104 (19.6)	0.029*
Two	534 (58.2)	230 (59.3)	304 (57.4)	
Three or more	186 (20.3)	64 (16.5)	122 (23.0)	
BP control, n (%)	340 (37.0)	152 (39.2)	188 (35.5)	0.251

The data are expressed as the mean ± SD or number (%). ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; BB, blood pressure; BMI, body mass index; CCB, calcium channel blocker.

Table 2. Blood pressure control according to antihypertensive medication by gender.					
Drugs	Female		Male		P-value
	n	Control rate	n	Control rate	
Overall, n (%)					
CCB	214	80 (37.4)	254	96 (37.8)	0.999
ACEI	130	44 (33.8)	242	80 (33.1)	0.908
Diuretic	116	54 (46.6)	170	58 (34.1)	0.037*
ARB	134	54 (40.3)	196	74 (37.8)	0.647
Beta blocker	154	62 (40.3)	236	90 (38.1)	0.673
Number of drugs, n (%)					
One	94	36 (38.3)	104	24 (23.1)	0.020*
Two	230	90 (39.1)	304	124 (40.8)	0.722
Three or more	64	26 (40.6)	122	40 (32.8)	0.334

The data are expressed as number (%). ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; CCB, calcium channel blocker.

Table 3. Medication use and blood pressure control in males and females across various age groups.

Drugs	Female		Male		P-value
	n	Control rate	n	Control rate	
CCB	34	14 (41.2)	48	15 (31.3)	0.042*
ACEI	32	8 (25.0)	54	22 (40.7)	0.165
Diuretic	22	12 (54.5)	22	10 (45.5)	0.763
ARB	12	6 (50.0)	24	10 (41.7)	0.729
BB	48	18 (37.5)	54	24 (44.4)	0.477
45-64 years, n (%)					
CCB	118	46 (39.0)	98	47 (48.0)	0.315
ACEI	48	20 (41.7)	92	28 (30.4)	0.195
Diuretic	50	24 (48.0)	96	34 (35.4)	0.157
ARB	86	34 (39.5)	98	38 (38.8)	0.999
BB	84	36 (42.9)	100	36 (36.0)	0.342
≥65 years, n (%)					
CCB	62	20 (32.3)	108	34 (31.5)	0.995
ACEI	50	16 (32.0)	96	30 (31.3)	0.999
Diuretic	44	18 (40.9)	52	14 (26.9)	0.193
ARB	36	14 (35.0)	74	26 (35.1)	0.833
BB	22	8 (36.3)	82	30 (37.5)	0.991

The data are expressed as number (%). ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; CCB, calcium channel blocker.

hormones like testosterone and estrogen play a crucial role in these gender- related variations in BP regulation (18, 19). In the present study, the prevalence of hypertension tended to be higher in female aged 45–64 compared to male in the same age group. Previous studies conducted in Turkey have reported the age of menopause to be between 45 and 47 years (20, 21). In women, the decline in estrogen is related to less elastic blood vessel walls, which can contribute to increased BP and a heightened risk of cardiovascular disease (22, 23). Moreover, menopause-related hormonal changes can result in both weight gain and heightened responsiveness to dietary salt, potentially causing an increase in BP levels (24). This aligns with the higher BMI and greater predisposition to obesity seen in hypertensive female relative to male.

Conflicting findings on BP control rates by gender have been reported in the current literature. Some studies have reported that uncontrolled hypertension is more prevalent in female, while others have found it to be higher in male (6, 24-26). On the other hand, a large-scale study carried out in the United Arab Emirates reported that overall BP control rates were similar across genders (27). Although BP control rates did not differ significantly between genders in the overall population, certain subgroup analyses revealed interesting patterns. Female using diuretics showed better BP control compared to male. This finding may reflect gender-specific pharmacodynamic responses to diuretics or differences in adherence to prescribed therapy (28). Furthermore, across all age groups, female using diuretics exhibited a tendency for higher BP control rates compared to men. A previous study reported that hypertensive patients aged 45–64 years or 65 and older using diuretics had better BP control rates in female compared to male. Furthermore, in middle-aged women, the use of diuretics or ARBs was linked to higher BP control compared to other antihypertensive drugs (29). On the other hand, some studies have indicated that diuretics are linked to lower BP control rates (28). The variations between studies could be related to differences in patient selection, the types of diuretics used, and their dosages. On the other hand, smoking, which is known to elevate blood pressure regardless of gender, could potentially affect the response to diuretics in women differently than in men. This warrants further investigation to clarify its role as a confounding factor in gender-specific blood pressure control.

The gender distribution of antihypertensive therapies in the current study aligned with previously reported findings, showing that ACEIs and BBs are more often prescribed to men, whereas CCBs are more commonly prescribed to women (30). However, the general BP control rates associated with these medications showed no significant variation between genders. In a 2008 study, data from 31 randomized clinical trials were reviewed,

and it was reported that antihypertensive medications showed no differences between men and women in reducing blood pressure or cardiovascular outcomes (31). On the other hand, the findings of this study revealed that among patients aged 18–44 using CCBs, women demonstrated better BP control rates than men. Similarly, a study from China found that CCBs were more effective in achieving BP control in women of this age group (29). Dry cough, a side effect of ACEI use, is reported more frequently in women than in men (32, 33), which could account for the lower prevalence of ACEI use in women. Additionally, ACEI use has been reported to achieve better BP control in men compared to women among hypertensive patients under 45 years old (29). However, there are also studies reporting the opposite (33). The use of ARBs showed comparable BP control rates between genders in all age groups. There are few studies in the existing literature that assess the impact of ARBs on BP control in relation to gender, and their results are conflicting. While some research indicates that ARBs result in better BP control in middle-aged women, other studies suggest they are more effective in men, whereas some find no gender-related differences in BP control rates (29, 34, 35). These differences may be related to the combination of antihypertensive medications. Therefore, further research is needed on this topic.

The current study had several notable limitations. First, the retrospective design may limit the ability to establish causal relationships between treatment patterns and outcomes. Second, potential confounding factors such as lifestyle behaviors, dietary sodium intake, and medication adherence were not thoroughly explored. Additionally, medication adherence was not examined. Finally, the sample was limited to a single healthcare setting, which may limit the generalizability of findings to broader populations.

Conclusion

This study highlights gender-related differences in antihypertensive treatment patterns and responses. While overall BP control rates were comparable between men and women, women demonstrated better control in specific scenarios, such as diuretic use and monotherapy. These findings emphasize the need for individualized treatment approaches that account for gender and other patient-specific factors to optimize BP control and reduce the burden of uncontrolled hypertension.

Conflict of Interest/ Funding: Funding

The study received no financial support from any individual or organization, and the authors declare no conflict of interest.

Ethics Committee Approval

The study was performed in accordance with the Declaration of Helsinki, and was approved by the Diskapi Yildirim Beyazit Training and Research Hospital Clinical Research Ethics Committee (Date: 20.06.2022, Decision No: 140/15).

Informed Consent

The need for informed consent was waived under the approval of the Local Ethics Committee due to the retrospective design.

Conflicts of Interest

The authors declare they have no conflicts of interest.

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Availability of Data and Material

The data that support the findings of this study are available on request from the corresponding author, [A.K.].

Author Contributions

Concept – A.K., Design- A.K. and V.O.T., Supervision - A.K., Data collection and/or processing - A.K. and V.O.T., Analysis and/or interpretation - A.K. and V.O.T., Writing – A.K., Critical review- V.O.T. All authors read and approved the final version of the manuscript.

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