Published in final edited form as:
J Hypertens. 2011 May ; 29(5): 1005–1011. doi:10.1097/HJH.0b013e3283449512.

Age Dependent Gender Differences in Hypertension Management

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Abstract

Objective—Despite gender neutral guidelines, prior studies suggest that women have lower rates of hypertension control and these differences may vary with age. Accordingly, we compared rates of hypertension control between women and men as a function of age.

Methods—Within 3 integrated healthcare systems in the Cardiovascular Research Network, we studied all patients seen from 2001–2007 with incident hypertension. Within 1-year of cohort entry, patient's hypertension was categorized as: 1) controlled based upon achieving guideline-recommended BP levels, 2) recognized if hypertension was diagnosed or a hypertension medication dispensed, and 3) treated based on hypertension medications dispensed. Multivariable logistic regression models assessed the association between gender and 1-year hypertension outcomes, adjusted for patient characteristics.

Results—Among the 152,561 patients with incident hypertension, 55.6% were women. Compared to men, women were older, had more kidney disease and more blood pressure measures during follow-up. Overall, men tended to have lower rates of hypertension control compared to women (41.2% vs. 45.7%, adjusted OR 0.93, 96% CI 0.91–0.95). A significant gender by age interaction was found with men aged 18–49 having 17% lower odds of hypertension control and men aged ≥ 65 having 12% higher odds of hypertension control compared to women of similar ages ($p<0.001$).

Conclusions—In this incident hypertension cohort, younger men and older women had lower rates of hypertension control compared to similarly aged peers. Future studies should investigate why gender differences vary by age in order to plan appropriate means of improving hypertension management regardless of gender or age.

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This work was presented as a poster at the American Heart Association 50th Cardiovascular Disease Epidemiology and Prevention Scientific Sessions on March 4th, 2010 in San Francisco.

Financial Disclosure: Dr. Ho serves as a consultant for Wellpoint Inc. All other authors report no conflicts on interest in regards to this manuscript

Keywords

Hypertension; gender; aging; treatment disparities

INTRODUCTION

Uncontrolled hypertension (HTN) is one of the most significant public health problems in the world today and is related to a significantly elevated risk of stroke, myocardial infarction, heart failure, and renal failure.[1, 2] The prevalence of HTN is increasing among both women and men in all age groups.[3] Data from national surveys suggests that only 1/3 of patients with HTN have their blood pressure controlled to recommended levels.[3, 4]

Current guidelines recommend similar approaches to HTN management regardless of gender.[5, 6] Despite these gender-neutral recommendations, some literature suggests that HTN management varies by patient gender. Specifically, in some studies, women have been shown to have worse rates of blood pressure control. [4, 7–12] However, other studies have found that women have equal or better HTN control than men.[13–15] Limitations in these prior works may explain these conflicting results. For example, many studies classified blood pressure control based on a single blood pressure measurement and lacked longitudinal follow-up. Importantly, no study has assessed gender differences in HTN control among an incident HTN cohort to account for severity of baseline blood pressure and subsequent HTN recognition and treatment. Finally, few studies consider gender differences as a function of age, particularly among younger age groups, which has been important in other studies of gender differences in cardiovascular care.[16, 17]

Accordingly, we sought to compare rates of HTN control within a year of meeting criteria for incident HTN among contemporary, ambulatory patients followed in three large integrated health care systems and to explore gender differences in HTN control as a function of patient age. Secondary analyses assessed gender differences in HTN recognition and treatment.

METHODS

Study Population

The study sample included patients within the Cardiovascular Research Network (CVRN) hypertension registry from 2001–2006 with incident HTN. The development of the CVRN hypertension registry has been described previously.[18, 19] In brief, patients with HTN in three integrated health systems (Health Partners of Minnesota, Kaiser Permanente Colorado, and Kaiser Permanente Northern California) were identified using a published algorithm based upon ICD-9 diagnosis codes, blood pressure (BP) measurements (from non-urgent visits), and pharmacy data.[20] For this paper, incident HTN was defined as: 1) ≥ 2 consecutive elevated BPs and a subsequent HTN diagnosis or HTN treatment; OR ≥ 3 consecutive elevated BPs regardless of subsequent diagnosis or treatment; AND 2) no prior diagnosis or treatment for HTN in ≥ 12 months prior to meeting entry criteria. Elevated BP was defined according to JNC7 thresholds of systolic blood pressure (SBP) ≥140 mm Hg or diastolic blood pressure (DBP) ≥90 mm Hg with lower cut-offs of 130/80 mm Hg for those with diabetes mellitus or chronic kidney disease.[6]

Since the study inclusion and outcome criteria rely on diagnoses codes and pharmacy data, patients were required to have continuous health plan enrollment for ≥ 1 year prior to and after cohort entry. Because the approach to HTN management differs in pregnancy, women with identified pregnancy were also excluded.

Independent Variables

The primary predictor variable for all analyses was patient gender. Other predictor variables considered in the multivariable models included: patient age, race/ethnicity, BP level at cohort entry, year of cohort entry, study site, number of BP measurements during the follow-up period and coexisting conditions. Coexisting conditions were determined based on ICD-9 diagnosis codes assigned at visits or entered on problem lists, prescribed medications, and laboratory data according to a pre-specified algorithm. To assess the relationship between gender and HTN control by age, we compared men and women in three age strata: 18–49 years (young), 50–64 years (middle) and ≥ 65 years (older).

Outcome Variables

The primary outcome of interest was HTN control based on the median of all blood pressures in the 1-year after period meeting incident HTN criteria and consistent with JNC7 guidelines (SBP ≤ 140 mm Hg or DBP ≤ 90 mm Hg with lower cut-offs of 130/80 mm Hg for those with diabetes mellitus or chronic kidney disease).[6] In accordance with current HEDIS measures, an alternative definition of HTN control using the last blood pressure in the follow-up interval was also tested. [21] As the results of this secondary analysis did not differ significantly from the primary approach, these data are not shown.

To explore how other processes of HTN management potentially differ by gender, secondary analyses compared the rates of the outcomes of HTN recognition and treatment by age and gender. Hypertension recognition was defined as a recorded diagnosis of HTN or a filled prescription for any antihypertensive medication (e.g., diuretics, B-blockers, ACE-inhibitors, etc.) occurring on or within one year of meeting study criteria for incident HTN. Hypertension treatment was defined as a filled prescription for any antihypertensive medication occurring on or within one year of study entry.

Statistical Analyses

Baseline characteristics were compared between women and men using the chi-square test for categorical variables or Wilcoxon rank sum tests for continuous variables. Multivariable logistic regression models assessed the association between gender and hypertension control adjusting for patient demographics, coexisting conditions, year of cohort entry, study site and number of blood pressures over follow-up. To ensure the findings were not site dependent, additional models assessed HTN control at each of the three study sites. These results were similar to the overall analysis for HTN control; therefore, the results are not presented.

Given literature suggesting gender differences are age dependent, stratified models assessed the interaction between gender and HTN control stratified by young (18–49 years), middle (50–64 years) and older (65 years) aged groups. The statistical significance of the differences among strata was tested with two-way interaction terms in the full model. Further analyses were performed among subgroups stratified by the presence of chronic kidney disease (CKD) or diabetes mellitus (DM).

Finally, to examine the extent to which age dependent gender difference in HTN control parallel other processes of HTN care, we examined gender differences in HTN recognition and treatment stratified by age. Multivariable logistic regression models controlled for the same covariates as the primary analysis models.

All analyses were performed using the SAS statistical package version 9.1 (SAS Institute, Cary, NC). The study was approved by the institutional review committee at participating sites.

RESULTS

Of the 288,916 patients initially identified with incident HTN in the CVRN hypertension registry, 108,294 (37.5%) were excluded because they did not have a full-year of prior membership, 3037 (1.1%) patients were excluded because of pregnancy and 25,024 (8.7%) were excluded due to lack of a full year of follow-up after cohort entry. The final study cohort included 152,561 patients; of whom 56% were women. Compared with men, women were older, had more chronic kidney disease, had more depression and had more BP measurements over the year of follow-up. (Table 1).

Overall, men had lower rates of HTN control compared to women (41.2% vs. 45.7%, $p<0.001$). (Figure 1). After adjusting for all variables in table 1, men continued to have lower rates of HTN control (OR 0.93, 95% CI 0.91–0.95). However, in stratified analysis, a significant gender by age interaction was found. Men had worse HTN control in the 18–49 year ($p<0.001$) and the 50–64 year ($p<0.001$) age groups, but in the group ≥ 65 years, men had better rates of HTN control than women ($p<0.001$). (Figure 1).

Similar findings were seen in subgroups stratified by the presence or CKD or DM. Specifically, younger men were significantly less likely than younger women to achieve HTN control (no CKD or DM: 43% men with control vs. 53% women with control, $p<0.001$; CKD or DM: 32% men with control vs. 38% women with control, $p<0.001$). In the older age groups, the gender difference was only significant in the patients with CKD or DM (37% control in men vs. 35% control in women, $p<0.001$)

Figure 2 shows the results of additional analyses examining other processes of HTN care by gender. Younger men had significantly lower rates of HTN recognition and treatment ($p<0.001$) compared to younger women while older men had significantly higher rates of HTN recognition and treatment compared to older women ($p<0.001$ for all).

DISCUSSION

In this contemporary cohort of patients with incident HTN, overall, men had worse rates of 1-year HTN control than women; however, the association between gender and HTN control varied substantially when examined in different age strata. Specifically, men 18–49 years old had 17% (95% CI, 16–20%) lower odds of having their HTN controlled at one year compared with women of similar age. Conversely, men ≥ 65 years old had a 12% (95% CI, 7–16%) higher odds of having their HTN controlled compared with women ≥ 65 years old. In stratified analysis, these findings were limited to older patients with CKD or DM. BP control rates were also slightly lower for men 50–64 years old compared to women 50–64 years old. Age dependent gender differences in HTN recognition and treatment initiation were also noted and paralleled the differences in HTN control for subjects 18–49 years old and ≥ 65 years old. Gender differences in HTN recognition, treatment, and control persisted even after controlling for other patient characteristics.

Prior studies of the relationship between gender and BP control have found better, no difference, and worse BP control for women versus men. [4, 7, 8, 10, 11, 13–15, 22] Our finding that the relationship between gender and BP control varies by age provides a potential explanation for the conflicting results of prior studies which were conducted in study populations with different age distributions. Additional strengths of this study included 1) use of a study population of patients with incident HTN (both recognized and unrecognized); 2) consideration of multiple BP measures over a year of follow-up instead of a single BP measurement to determine HTN control; and 3) concurrent assessment of HTN processes of care including HTN recognition and treatment initiation.

To our knowledge, this is the first large community based study to demonstrate that among a cohort of patients with incident HTN, gender differences in 1-year HTN control vary by age. We found that among patients ≥ 65 years old with incident HTN, older women were less likely to have their elevated BP recognized and less likely to have anti-hypertensive medications initiated than older men, suggesting that provider-based processes of care contribute to lower rates of HTN control for older women compared to older men. These findings are consistent with prior studies suggesting significant improvements in HTN awareness, treatment and control among men but not women over 60.[4] Other potential explanations for lower rates of HTN control in older women compared to older men include poorer adherence to prescribed medications or lifestyle recommendations and physiological differences in HTN control due to vascular stiffness and/or sex hormones.[23]

On the opposite end of the age spectrum, and consistent with earlier cross sectional data, we found lower HTN control among young (18–49 years old) men compared to young women.[24] Premenopausal women are known to have lower blood pressure then age matched men again suggesting sex hormones may influence age dependent gender differences in HTN control.[23, 25] As hypothesized for the older age groups, the likelihood of treatment intensification and patient adherence to medications or life style recommendations may differ between young men and women. Another possible explanation for the gender differences seen in the young is that young women may access the health care system more often and have more opportunities for HTN control compared to young men.[26] However, in this study, young men had worse HTN control even after adjustment for the number of blood pressure measurements, suggesting visit frequency does not completely explain observed differences. Finally, HTN recognition and treatment were also lower among young men compared to young women suggesting that provider actions, as well as patient factors, may influence the age dependent gender differences demonstrated.

Certain factors should be considered in the interpretation of the study results. First, this study relies on BP measurements from an electronic medical record. However, methods for determining HTN have been previously validated using chart review. Furthermore, the methods for determining HTN outcomes were applied equally by gender. Second, the findings in these healthcare systems may not be generalizable to other healthcare settings. However, these 3 systems care for >4 million patients in geographically distinct areas and the results for overall HTN control did not significantly vary across sites (date not shown). Third, it was not possible to measure lifestyle interventions for this analysis. Differences in adherence to lifestyle recommendations or how providers prescribe them could vary by age and gender and potentially explain some of the differences seen in HTN control. Similarly, variables such as education and income were not collected in this data set and their relationship to blood pressure control could not be determined. Fourth, at baseline, the proportion of women in the older age group was higher and women tended to have higher rates of CKD and DM which could affect subsequent comparisons of blood pressure outcomes. We have attempted to control for these baseline differences in two ways: 1) by controlling for age and comorbidities in the primary analysis; and 2) by stratifying by age and CKD or DM status in secondary analyses. The results of the secondary analysis were similar to the primary analysis. Fifth, medication adherence was not considered in the models comparing HTN control by age and gender. However, some studies suggest gender is not a significantly associated with adherence to HTN medications.[27] Finally, with large sample sizes it is possible to find statistically significant differences that are not necessarily clinically meaningful. However, at a population level, the absolute differences in control rates (40.5% young men vs. 49.4% young women; 42.5% older men vs. 41.5% older women), are of at least modest size, particularly in the younger age groups, and could potentially translate into significant differences in longer term cardiovascular events.

Therefore, these findings have significant importance from a public health perspective and warrant further investigation.

Overall, the findings of this study have several clinical and research implications. First, current rates of HTN control for men and women of all ages remain below the 50% targeted by initiatives such as Healthy People 2010.[28] Therefore, this study suggests that despite initiatives to improve blood pressure control, HTN control rates remain low for women and men suggesting substantial missed opportunities for the prevention of cardiovascular disease. Second, control was lowest among younger men and older women. Therefore, system changes directed at improving HTN control should devote more attention to BP management in these important populations. Third, gender differences in HTN recognition and treatment were also demonstrated; further studies are needed to determine the provider factors that may explain these differences in HTN processes of care. Finally, these age dependent findings stress the need to study all age groups when looking for gender differences.

Conclusion

In this cohort of patients from 3 healthcare systems with incident HTN, younger men and older women had lower rates of HTN control compared to women and men of similar age. Future studies should investigate why gender differences vary by age in order to plan appropriate means of improving HTN management regardless of gender or age.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding Sources: The Cardiovascular Research Network is supported by a grant from the National Heart Lung and Blood Institute of the NIH (U19HL91179-01). Dr. Daugherty is supported by grants from the Center for Women's Health Research at the University of Colorado Denver and the National Heart Lung and Blood Institute (K08HL103776-01). Dr. Schmittdiel is supported by the Office of Research in Women's Health Building Interdisciplinary Careers in Women's Health K12 Career Development Award (K12HD052163).

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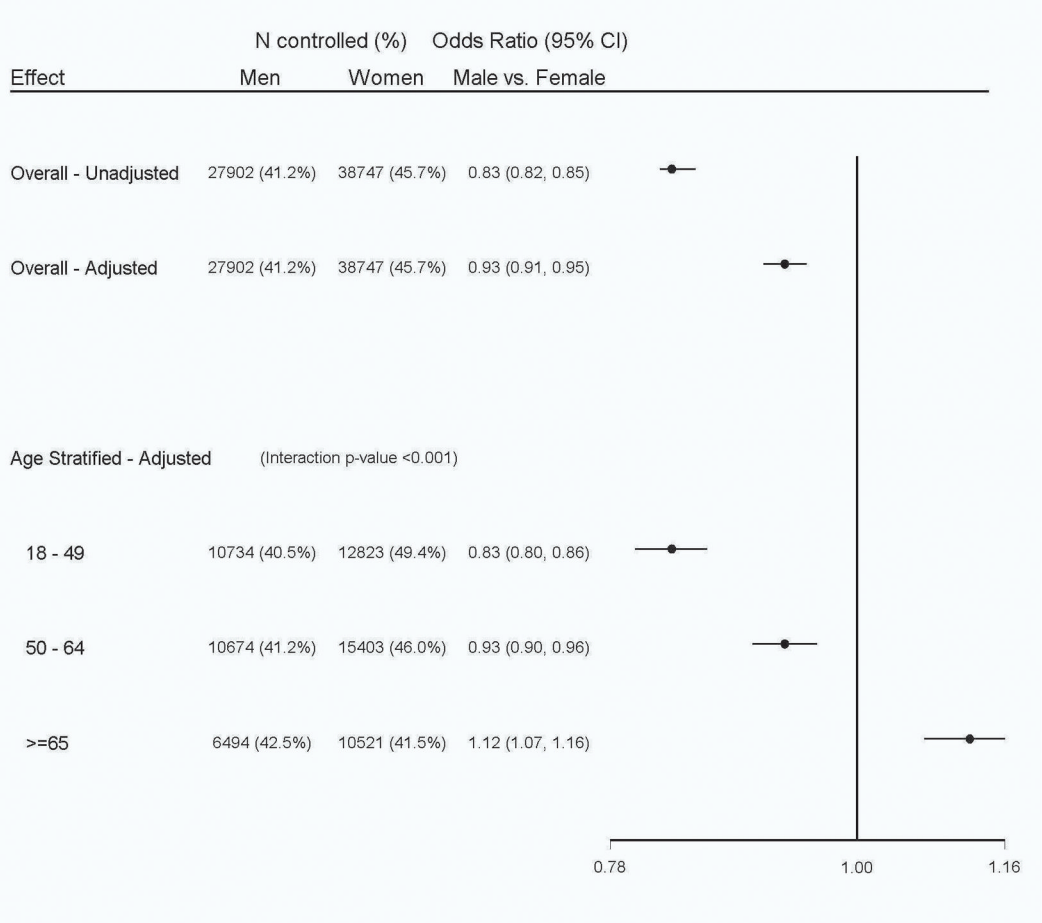

Figure 1.
Rates of HTN control in men compared to women. Adjusted models control for patient age, race, BP level at cohort entry, year of cohort entry, study site, number of BP measurements during the follow-up period and coexisting conditions.

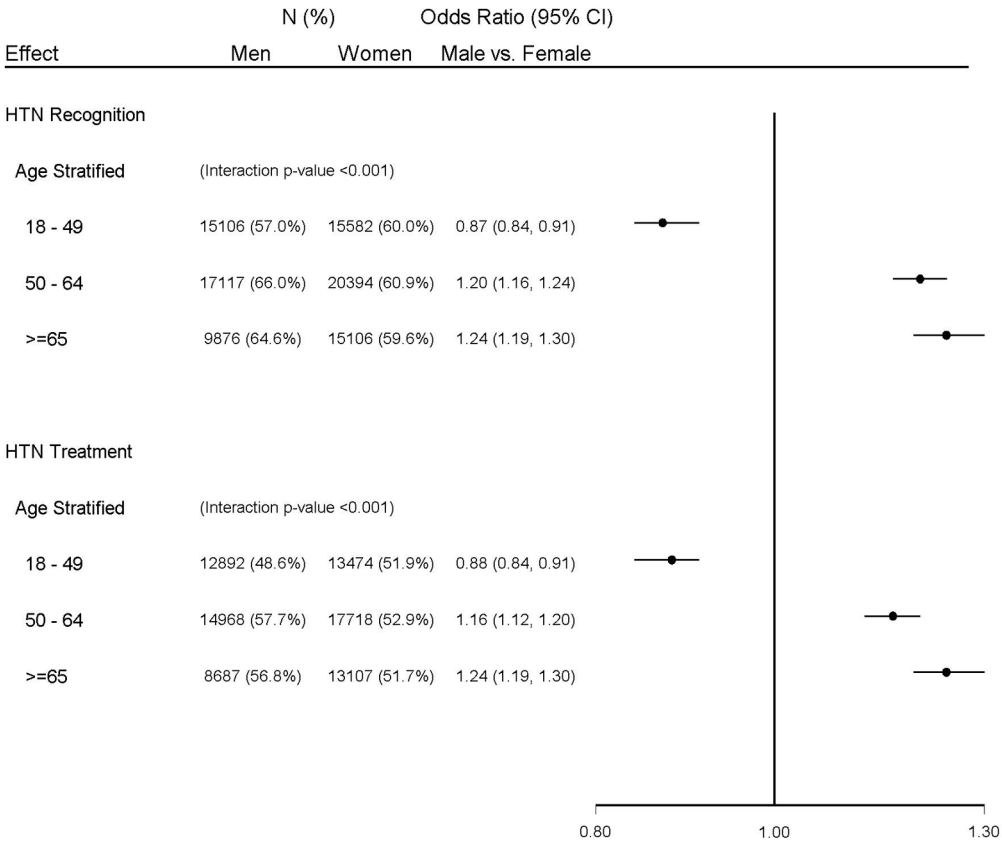

Figure 2.

Rates of HTN recognition and treatment in men compared to women stratified by age. Models control for patient age, race, BP level at cohort entry, year of cohort entry, study site, number of BP measurements during the follow-up period and coexisting conditions.

Table 1

Baseline study population characteristics

Characteristic	Women (n=84,839)		Men (n=67,722)		
	Median	(5%,95%)	Median	(5%,95%)	p-value
Age	56	(36, 80)	53	(31, 78)	<0.001
Blood pressure at entry					
Systolic blood pressure	147	(135, 168)	147	(132, 168)	<0.001
Diastolic blood pressure	87	(70, 104)	91	(70, 104)	<0.001
No. of blood pressures over f/u	3	(0, 10)	2	(0, 8)	<0.001
Age group	N	%	N	%	p-value
18–49	25,976	30.6%	26,510	39.1%	<0.001
50–64	33,512	39.5%	25,924	38.3%	
≥ 65	25,351	29.9%	15,288	22.6%	
Site					
Kaiser Permanente Colorado	9,411	11.1%	8,495	12.5%	<0.001
Kaiser Northern California	72,142	85.0%	56,217	83.0%	<0.001
Health Partners Minnesota	3,286	3.9%	3,010	4.4%	<0.001
Race/Ethnicity					
White	49,237	58.0%	34,922	51.6%	<0.001
Black	6,653	7.8%	4,047	6.0%	
Hispanic	8,583	10.1%	6,234	9.2%	
Asian	7,917	9.3%	5,474	8.1%	
Other	1,483	1.8%	1,006	1.5%	
Unknown	10,966	12.9%	16,039	23.7%	
History of:					
Chronic kidney disease	4,757	5.6%	3,061	4.5%	<0.001
Diabetes mellitus	11,295	13.3%	12,753	18.8%	<0.001
Coronary artery disease	520	0.6%	1,010	1.5%	<0.001
Myocardial infarction	74	0.1%	89	0.1%	0.009
Congestive heart failure	131	0.2%	123	0.2%	0.195
Peripheral vascular disease	296	0.3%	417	0.6%	<0.001
Cerebral vascular disease	945	1.1%	767	1.1%	0.731

Characteristic	Women (n=84,839)		Men (n=67,722)		
	Median	(5%,95%)	Median	(5%,95%)	p-value
Hyperlipidemia	8,615	10.2%	8,317	12.3%	<0.001
Cancer	13,621	16.1%	8,184	12.1%	<0.001
Depression	8,441	9.9%	3,369	5.0%	<0.001
Dementia	526	0.6%	267	0.4%	<0.001
Connective tissue disease	1,424	1.7%	391	0.6%	<0.001
Thyroid disease	5,763	6.8%	1,236	1.8%	<0.001
Chronic pulmonary disease	8,570	10.1%	5,091	7.5%	<0.001