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Sexual Activity and Function among Middle-Aged and Older Men and Women with Hypertension

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Antihypertensive medication is commonly implicated as a reason for sexual problems. However, data supporting a cause-effect relationship are discordant.^{1–6} In studies of men, beta-blockers and diuretics are associated with erectile dysfunction; yet other studies dispute this association.^{7–16} Among women, studies largely focus on the premenopausal years.^{17,18} Most studies are not designed to investigate the full spectrum of sexual health, nor are they conducted by professionals with training in these types of questions.^{19–22} Furthermore, few have investigated the specific effects of medication class on sexual activity and function in a prospective fashion.^{17–19} The paucity of quality data about sexual health and its relationship to hypertension and its treatment diminish the ability of clinicians to counsel patients about medication side effects and potential sexual problems.

Adults of all ages consider sexual health to be an important component of health; thus, maintenance of sexual function is important throughout the lifespan.^{3,23–29} Prior studies demonstrate that loss of sexual activity and function among older adults is associated with the absence of an intimate partner, poor physical health, and disease affecting vascular integrity.^{21,22,24,27,30,31} In the case of hypertension (HTN), a disease affecting over two-thirds of the older adult population, both the disease and the treatment may impact sexual function.³² Having a clearer understanding of the association of HTN and specific

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antihypertensive medication classes with sexual health among older adults may help in tailoring approaches for individual patients.

Accordingly, we used data from The National Social Health, Life and Aging Project (NSHAP), designed to better understand how social relationships, including sexual relationships, influence people's health as they age. We investigated the association of HTN status, using objective measurements of blood pressure and in-home assessment of antihypertensive medication use, with sexual activity and problems among a cohort of middle-aged and older adults, and whether these relationships varied by sex. We further examined the independent effects of the common classes of medication used to treat HTN in this population.

Methods

NSHAP is conducted by the National Opinion Research Center (NORC) and investigators from the University of Chicago; details of this study have been previously described.²⁴ The first wave was conducted between July 2005 and March 2006 and includes a nationally representative sample of community residing adults between the ages of 57 and 85 years. Of the 4,017 selected eligible survey participants, 3,005 completed face-to-face interviews with trained researchers, yielding an overall weighted survey response rate of 75.5%.

Sample Population

We categorized individuals into three groups by HTN status: HTN Treated, HTN Untreated, and No HTN. Only adults with valid responses for self-report to having a diagnosis of high blood pressure along with valid blood pressure measurements were included. Adults were considered to have HTN if they: (1) responded 'yes' to ever being told by a medical doctor that they had high blood pressure and had either elevated blood pressure (mean systolic pressure of ≥ 140 mmHg or mean diastolic pressure ≥ 90 mmHg), or (2) responded 'yes' to having high blood pressure and had a normal blood pressure measurement (mean systolic <140 mmHg and mean diastolic <90 mmHg) but were taking an antihypertensive medication, or (3) responded 'no' to having high blood pressure, yet had an elevated mean blood pressure measurement (Undiagnosed HTN). The mean systolic and mean diastolic values were obtained by taking the average of two blood pressure measurements, taken from the left arm after sitting in a chair for at least 5 minutes. A third reading was obtained if the difference between the first two systolic readings was ≥ 20 mmHg, or if the diastolic readings differed by ≥ 14 mmHg.

Participants were asked to provide the interviewer with the containers for all medications used "on a regular schedule, like every day or every week." These medications were entered into the Lexicon Plus[®] medication data file. Antihypertensive medications were catalogued into one of the following medication classes: angiotensin-converting-enzyme inhibitor (ACEi), angiotensin II receptor blocker (ARB), diuretic, beta-adrenergic blocker, calcium channel blocker, vasodilator, centrally or peripherally acting antiadrenergic medication, or antihypertensive combination.^{33,34} For this analysis, we combined these medications into five classes of medication commonly prescribed for HTN: (1) calcium channel blockers, (2) beta-blockers, (3) diuretics, (4) ACEi and/or ARBs and (5) alpha-blockers. Adults taking more than one class of medication were included in each of the respective medication groups; thus, categories are not mutually exclusive. Adults with undiagnosed or diagnosed HTN who did not report taking an antihypertensive medication were classified as Untreated HTN. Adults identified to have 'No HTN,' both by self-report and blood pressure measurement, but who reported taking one of the above classes of medication, were excluded from the analysis, as these medications may be used for indications other than HTN (n=213). Additionally, adults who responded yes to having been told they had high

blood pressure but had normal blood pressure measurements and were not taking an antihypertensive medication were excluded (n=58).

Outcome Variables

The main outcome variables were partnered sexual activity in the past year and, among adults who were sexually active with a partner, the presence of any sexual problem. Sexual activity was defined as “any mutually voluntary activity with another person that involves sexual contact, whether or not intercourse or orgasm occurs.” Masturbation was assessed separately. Men and women who were sexually active with a partner in the past year were asked if they experienced any of the following sexual problems: a lack of interest, inability to climax, physical pain during intercourse, sex that was not pleasurable, and an inability to perform because of anxiety. Additionally, men were asked if they were unable to achieve or maintain an erection. Women were additionally asked if they had difficulty with lubrication, and experienced genital tingling or arousal. Overall, 2 to 7% of respondents declined to answer questions about sexual activities and problems; 14% declined to answer the question, on a self-administered questionnaire, regarding masturbation.²⁴

Covariates

We considered several covariates that may influence sexual activity and problems in this cohort.^{24,27} Sociodemographic characteristics included: age, race/ethnicity, insurance, and relationship status.^{21,26} Respondents who were married or cohabiting at the time of the survey or who reported having a “romantic, intimate, or sexual partner” were referred to as having a “spousal or other intimate relationship.” HTN severity was assessed using guidelines from the Joint National Committee (JNC) 7.^{19,35} We assessed smoking status, and self-reported diabetes, heart disease, and cerebrovascular disease. Adults who did not self-report diabetes, but who had a hemoglobin A1c $\geq 6.5\%$ or who were taking a glucose lowering medication were additionally considered to have diabetes.³⁰ Depression was assessed using the abbreviated, 11-item Center for Epidemiologic Studies Depression Scale (CES-D), which has been validated in the elderly; scores ≥ 9 are consistent with clinically significant depressive symptoms.^{36,37} Functional status was categorized as poor if respondents reported ‘a lot’ or ‘some’ difficulty with walking across a room, bathing, dressing, getting in/out of bed, or using the toilet.

Data Analysis

We describe the sociodemographic and clinical characteristics of adults with Treated HTN, Untreated HTN, and No HTN, and compare the prevalence of sexual activity and problems among these groups. The relationship between being treated for hypertension and sexual activity was significantly modified by gender. As a result, we conducted and present gender stratified analyses. We performed bivariate analyses exploring the association of HTN status with sexual activity and any sexual problem and, among the Treated HTN group, between medication class and sexual activity/sexual problems. For each class of antihypertensive medication, comparisons were made with adults not taking a medication from that class. We performed backward stepwise logistic regression analyses to assess the independent effects of HTN status and antihypertensive medication classes on sexual activity and problems. These models were performed separately for men and women. Only covariates that were significant at the 0.1 level were kept in the model. Non-significant covariates included: race/ethnicity, mean systolic pressure, mean diastolic pressure, hypertension severity by JNC 7 stage, cerebrovascular disease, and use of an antidepressant medication. Model 1 is adjusted for other antihypertensive medication classes. Model 2 is adjusted for Model 1 plus age, partner status, insurance, diabetes, heart disease, smoking, functional status, and depression. To prevent over-fitting, we ensured that for all models, the covariates included did not exceed 15 observations per variable.^{38,39} We did not adjust for multiple comparisons. SAS-

callable SUDAAN software 10.0 (Research Triangle Institute 2001, Research Triangle Park, NC) was used to account for the nonrandom probability sample design.

Results

Sociodemographic and clinical characteristics of the sample are reported in Table 1. Men with Treated HTN (n=734; 56.3%), as compared with men with Untreated HTN (n=274; 22.2%) and men without HTN (n=247; n=21.2%), were more likely to be older, Medicare recipients, and to have comorbid diabetes, heart disease, cerebrovascular disease, antidepressant medication use, and functional impairment. Relationship status did not vary by HTN status. Mean systolic and mean diastolic blood pressures were highest among the Untreated HTN group [mean systolic= 152.2mmHg, standard error (SE)=1.0; mean diastolic= 89.4mmHg (SE=0.8)], followed by the Treated HTN group [140.0mmHg, (SE=0.8)/80.3mmHg (SE=0.6)], then No HTN group [122.9mmHg (SE=0.7)/76.3mmHg (SE=0.6)]. Undiagnosed HTN represented 76.5% of the Untreated HTN group in men.

Women with Treated HTN (n=858; 57.3%), as compared with Untreated HTN (234; 18.0%) and no HTN (n=298; 24.7%), were more likely to be older, African American, and with comorbid diabetes, heart disease, cerebrovascular disease, and functional impairment. They were less likely to be in a spousal or intimate relationship. As in men, mean systolic and mean diastolic blood pressures were highest among the Untreated HTN group [150.0mmHg (SE=1.1)/91.0mmHg (SE=0.6)], followed by the Treated HTN group [140.0mmHg (SE=0.8)/82.6mmHg (SE=0.5)], then No HTN group (119.9mmHg (SE=0.6)/75.9mmHg (SE=0.5)]. Undiagnosed HTN represented 82.0% of the Untreated HTN group in women.

HTN Status and Sexual Activity/Sexual Problems

The prevalence of sexual activity and any sexual problem varied by HTN status (Table 2). In men, partnered sexual activity was less common in the Treated HTN group (66.5%) as compared with the Untreated HTN (75.9%) and no HTN (71.5%; $p<0.01$) groups. Of note, among the Untreated HTN group, sexual activity varied by whether HTN was diagnosed (63.4%) versus undiagnosed (79.2%; $p<0.01$). We also assessed masturbation among men and found no difference among the HTN groups (50.9% vs. 54.3% vs. 53.3%, $p=0.76$, respectively). The prevalence of any sexual problem among those who were sexually active with a partner was high and was more common among men with Treated HTN (69.1%) versus Untreated HTN (57.7%) and no HTN (54.3%; $p<0.01$).

Among women, partnered sexual activity was also less common among those with HTN, but did not differ by treatment status (Treated HTN=35.2%; Untreated HTN=38.3%; No HTN=58.0, $p<0.01$). Among the Untreated HTN group, prevalence estimates of sexual activity did not vary by diagnosis status (Diagnosed HTN= 36.1% vs. Undiagnosed HTN=39.1%, $p=0.68$). In the subgroup of women in a spousal or intimate relationship, the prevalence of sexual activity was equivalent to men, but the differences between HTN subgroups reflected the pattern seen in the overall female cohort: Treated HTN=60.3%; Untreated HTN=63.8 %; No HTN=77.0%, $p<0.01$. In contrast, women with Treated HTN were less likely to report masturbation in the past year (19.7%) as compared with women with Untreated HTN (30.4%) and No HTN (31.8%, $p<0.01$). The prevalence of having any sexual problem was high, but did not significantly vary by HTN status (Treated HTN 73.7%; Untreated HTN=65.3%; No HTN=71.7%, $p=0.30$).

In multivariable models (Table 2), among men, Treated HTN was no longer significantly associated with decreased sexual activity [adjusted OR=0.86 (95% CI: 0.51–1.45), $p=0.56$]. However, Treated HTN continued to be associated with a higher odds of sexual problems, though this was nonsignificant [adjusted OR=1.49 (95% CI: 0.94–2.37), $p=0.09$]. Among

women, both Treated HTN [adjusted OR=0.61 (95% CI: 0.39–0.95), $p=0.03$] and Untreated HTN [adjusted OR=0.54 (95% CI: 0.30–0.96), $p=0.04$] were associated with decreased sexual activity, yet were not associated with sexual problems.

Antihypertensive Medication Class and Sexual Activity/Sexual Problems

The prevalence of sexual activity was lower among men taking beta-blockers than among men not taking beta-blockers (Table 3, 55.5% vs. 64.4%, $p=0.03$) and among men taking diuretics versus not taking diuretics (55.3% vs. 64.2%, $p=0.03$). However, for all other antihypertensive medication classes, there were no significant differences in sexual activity or presence of any sexual problem in either men or women.

In multivariable models (Table 4), beta-blocker use in men was not significantly associated with sexual activity after adjusting for other medication classes and potential confounders [unadjusted: OR=0.69 (95% CI: 0.50–0.96), $p=0.03$; Model 1: OR=0.68 (95% CI: 0.48–0.96), $p=0.03$; Model 2: OR=0.84 (95% CI: 0.52–1.36), $p=0.48$]. Similar trends were found with diuretic therapy [unadjusted: OR=0.69 (95% CI: 0.50–0.96), $p=0.03$; Model 1: OR=0.70 (95% CI: 0.50–0.98), $p=0.04$; Model 2: OR=0.78 (95% CI: 0.49–1.24), $p=0.29$]. Among women, only diuretics were significantly associated with decreased sexual activity after adjusting for other medication classes and potential confounders [Model 2: OR=0.59 (95% CI: 0.38–0.92), $p=0.02$].

With the exception of ACEi/ARBs, which were associated with a lower odds of having any sexual problems in men, [Model 2: OR=0.53 (95% CI: 0.30–0.93), $p=0.03$], we did not find any significant associations between individual medication classes and sexual problems in either men or women (Table 5).

Comment

In this nationally representative study of middle-aged and older adults, over two-thirds had HTN; half were sexually active. Yet for men and women, the association of HTN and its treatment with sexual activity and problems were different. Among men, neither the diagnosis of HTN nor its treatment was significantly associated with sexual activity when accounting for antihypertensive medication class and other key clinical and sociodemographic characteristics. However, men with treated HTN had a higher, though non-significant odds of experiencing sexual problems as compared with having untreated HTN or no HTN. Among women, having either treated or untreated HTN was associated with a lower odds of sexual activity. Yet, among sexually active women, there were no associations between HTN status and sexual problems.

Our investigation into the association of antihypertensive medication class with sexual activity and sexual problems revealed no consistent relationships. While women taking diuretics had a lower odds of sexual activity, and men taking ACEi/ARBs had a lower odds of having a sexual problem, we found no additional associations between class of antihypertensive medication and the prevalence of sexual activity or having a sexual problem.

These findings contradict commonly held perceptions regarding HTN itself, along with specific antihypertensive medication classes, and their association with sexual dysfunction. Physiologically, HTN alters arterial blood supply to sexual organs by reducing arterial lumen diameter, increasing wall thickness, and inducing endothelial dysfunction. Yet, whether these changes result in erectile dysfunction in men or impaired physiologic arousal response (genital engorgement, swelling, and lubrication) in women remains unknown. The relationship is further complicated by blood pressure-lowering therapies, which may further

reduce blood supply to sexual organs, along with the potential sexual side-effects associated with specific antihypertensive medications.^{15,40,41}

We attempted to isolate the effects of HTN and antihypertensive medications among multiple, co-occurring medical conditions and treatments that may contribute to sexual health in this population. As compared to populations typically studied in hypertension clinical trials, in this U.S. population-based study there was a higher prevalence of complex disease among adults with treated HTN as compared with untreated HTN, rendering the two groups different in ways other than just treatment status. We additionally considered relationship factors which may influence men and women differently.

In our study, women with both treated and untreated HTN had a lower odds of being sexually active than women without HTN. These differences were observed after controlling for age, relationship status, insurance, and several comorbid diseases including CAD and depression. They were also observed in the subgroup of women who were married or in an intimate relationship. One explanation is that the physiologic changes associated with HTN may have resulted in sexual problems with subsequent avoidance of sexual activity (resulting in an underestimation of sexual problems among those with treated HTN). Alternatively, the diagnosis of HTN may serve as a marker of poor health status unaccounted for by adjustment for comorbid conditions, or may act as a driver of illness behavior.⁴³ However, if HTN is a marker of poor health, then we might expect the prevalence of masturbation to follow similar trends as partnered sexual activity, yet this was not the case. Furthermore, given that women with diagnosed and undiagnosed HTN had a similar prevalence of sexual activity, it is unlikely that illness behavior explains the differences observed.

This study is the first to report on the sexual health of middle-aged and older women with HTN in a nationally representative sample with objective evaluation of HTN and its treatment, and comprehensive assessment of sexual health. Our findings add to a small body of literature that suggests a negative association between HTN and sexual function among younger women.²⁰ Duncan and colleagues evaluated sexual problems in 110 premenopausal women with mild HTN (67 of whom were receiving treatment) compared with 107 healthy controls, and found that diagnosed HTN, but not its treatment, was associated with decreased lubrication and orgasm, and increased pain.¹⁸ By contrast, in a study by Dumas et al of 417 women with HTN (aged 30–60 years) attending an ambulatory HTN clinic, uncontrolled blood pressure and use of beta-blockers were associated with poorer sexual function; yet this study did not adjust for other comorbidities.¹⁹ Studies of older women have been limited. Shifren conducted a mail survey (overall response rate=63%; n=31,581) of a nationally representative panel of women 18 years and older (20% of whom were over age 65), and found no association between self-reported HTN and sexual desire, arousal, or orgasm.²⁰ Our study differs in several ways from prior studies, which may explain the discrepant results. Our large, probability sample of middle-aged and older adults lends itself to multivariable analysis and generalizability to the community-residing population. Secondly, questions about sexuality were asked face-to-face in the larger context of a survey about social and intimate relationships (75.5% response rate), which may have led respondents to be more open about their sexual activity and problems. Thirdly, in contrast to population-based analyses which found no association between self-reported HTN and sexual function,²⁰ we included blood pressure measurements to define HTN status which revealed an additional 20% of women with undiagnosed HTN; inclusion of these patients in the no HTN group in prior studies may have biased their findings towards the null.

Our study also has important implications for men. Antihypertensive medication has long been perceived as a major culprit of male sexual dysfunction.^{2,15,44} Yet this relationship is

not consistently supported in the medical literature. In a quantitative review of 6 randomized trials involving beta-blocker therapy, men taking beta-blockers, as compared with men taking placebo, had a 1.1 odds (95% CI: 0.96–1.25) of sexual inactivity, lack of desire, or impotence.⁸ Several other clinical trials not included in this review have also failed to find an association between beta-blocker use and erectile problems.^{13,14,45} Similarly, data supporting an association between diuretic medication and sexual activity in men are discordant.^{5,41,46} Suzuki et al reported that men taking chlorthalidone experienced more erectile problems (15.7%) than men taking placebo (4.9%; $p<0.01$).¹⁴ Grimm also found an increase in erectile problems among men taking chlorthalidone.⁴ Some smaller studies, however, demonstrate no association.^{7,41} While erectile problems are a key reason for sexual inactivity in men, our study did not find an association between diuretic medication and sexual activity.²⁷ Rather, women taking diuretic medication were less likely to report sexual activity. Lastly, in neither men nor women was diuretic therapy associated with sexual problems.

The association of ACEi/ARB with the absence of sexual problems has been observed in prior studies.^{11,12,14,16} One explanation is that medications inhibiting the renin-aldosterone system induce vascular remodeling which may be important for preserving and/or improving blood flow to sexual organs. However, a recent substudy of two trials of 1549 men, one comparing ramipril, telmisartan, and a combination of the two medications, and the second comparing telmisartan with placebo, failed to demonstrate improvement in erectile dysfunction with any of the active medications, though also did not appreciate any adverse effects on sexual function.⁴⁷ Men in these trials had a higher baseline prevalence of cardiovascular disease, stroke, and diabetes, which may explain the discrepancies between our findings. The association found here should be investigated further in larger, prospective clinical trials of men with and without cardiovascular disease, as well as in women. Currently there are no FDA-approved medical therapies aside from estrogen products to treat female sexual dysfunction. Non-hormonal therapies are needed to address vaginal dryness and dyspareunia associated with vaginal atrophy, as well as arousal problems, both of which may be related to genital blood flow.

Our study has some limitations. We attempted to isolate the specific effects of HTN and its treatment on sexual health; however in categorizing HTN by its diagnosis and treatment, we may have decreased our power to find a difference if one exist. Second, in this cross sectional study we were not able to evaluate the temporal relationship of HTN onset or its duration, and treatment initiation or its duration, with drop out from sexual activity or development of specific sexual problems. To our knowledge, there are no studies evaluating the duration of HTN with sexual function, as data on HTN duration are unreliable in studies not designed to detect incident HTN. Sexual problems related to treatment typically appear soon after initiation of medication and are unlikely to be related to the duration of treatment. Still, respondents may have avoided or switched classes of medication because of the potential for or occurrence of sexual problems, which may underestimate the association between specific medication classes and sexual problems. Furthermore, this study was not designed to evaluate whether antihypertensive treatment caused other adverse complications, such as diabetes, which can impact sexual activity and function. Third, the effects of an individual medication class may have been mitigated by polypharmacy, specifically multiple antihypertensive medication use, common in this population.³⁴ Notably, among adults treated for HTN, 57.2% of women and 60.2% of men were taking more than one antihypertensive medication. We were not powered to investigate the associations of each combination of antihypertensive medication therapy with sexual activity and function. Nevertheless, after adjusting for other antihypertensive medication classes, we found no consistent associations with sexual activity and problems. Fourth, as compared with adults with untreated HTN, adults with treated HTN had a higher prevalence

of heart disease, cerebrovascular disease, and diabetes, all of which may effect sexual function. We attempted to control for these differences by adjusting for these comorbid diseases. Additionally, we adjusted for functional impairment as a proxy for other debilitating diseases and health status factors which may not have been measured, but may have influenced our findings. Finally, in combining adults with diagnosed but untreated HTN with adults with undiagnosed HTN, we did not have the ability to fully discern the psychological effects of having a HTN diagnosis on sexual activity or problems. Ultimately, prospective, comparative effectiveness studies are needed to better understand the association of different HTN treatment strategies and their effect on quality of life, including sexual health.

Conclusion

Prior studies suggest a potential relationship between HTN and sexual activity and problems, though none have been designed to understand specific differences in treatment strategies on sexual health in men and women. Among a nationally representative sample of middle-aged and older adults, we attempted to better define these complex relationships. We found that among men with HTN, regardless of their treatment status, there was no association with sexual activity and non-significant associations with sexual problems. Women with treated HTN and untreated HTN were significantly less sexually active than women with no HTN, yet among sexually active women, neither the diagnosis of HTN nor its treatment were associated with sexual problems. In contrast to prior studies, we found no consistent associations between specific antihypertensive medication classes and sexual problems. Prospective, comparative effectiveness trials are needed to understand the effects of different HTN treatment strategies on important aspects of physical function, including sexual function, especially among older adults.

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References

1. Saigotov RT, Glezer MG. Effect of arterial hypertension on sexual health of men and their quality of life. Results of BOLERO study. *Kardiologiia*. 2009; 49(9):44–50. [PubMed: 19772502]
2. Manolis A, Doulas M. Sexual dysfunction: the 'prima ballerina' of hypertension-related quality-of-life complications. *J Hypertens*. Nov; 2008 26(11):2074–2084. [PubMed: 18854743]
3. Johannes CB, Araujo AB, Feldman HA, Derby CA, Kleinman KP, McKinlay JB. Incidence of erectile dysfunction in men 40 to 69 years old: longitudinal results from the Massachusetts male aging study. *J Urol*. Feb; 2000 163(2):460–463. [PubMed: 10647654]
4. Grimm RH Jr, Grandits GA, Prineas RJ, et al. Long-term effects on sexual function of five antihypertensive drugs and nutritional hygienic treatment in hypertensive men and women. Treatment of Mild Hypertension Study (TOMHS). *Hypertension*. Jan; 1997 29(1 Pt 1):8–14. [PubMed: 9039073]
5. Francis ME, Kusek JW, Nyberg LM, Eggers PW. The contribution of common medical conditions and drug exposures to erectile dysfunction in adult males. *J Urol*. Aug; 2007 178(2):591–596. discussion 596. [PubMed: 17570434]

6. Curb JD, Borhani NO, Blaszkowski TP, Zimbaldi N, Fotiu S, Williams W. Long-term surveillance for adverse effects of antihypertensive drugs. *Jama*. Jun 14; 1985 253(22):3263–3268. [PubMed: 3999311]
7. Rosen RC, Kostis JB, Jekelis A, Taska LS. Sexual sequelae of antihypertensive drugs: treatment effects on self-report and physiological measures in middle-aged male hypertensives. *Arch Sex Behav*. Apr; 1994 23(2):135–152. [PubMed: 8018020]
8. Ko DT, Hebert PR, Coffey CS, Sedrakyan A, Curtis JP, Krumholz HM. Beta-blocker therapy and symptoms of depression, fatigue, and sexual dysfunction. *Jama*. Jul 17; 2002 288(3):351–357. [PubMed: 12117400]
9. Newman HF, Marcus H. Erectile dysfunction in diabetes and hypertension. *Urology*. Aug; 1985 26(2):135–137. [PubMed: 4024403]
10. Moulik PK, Hardy KJ. Hypertension, anti-hypertensive drug therapy and erectile dysfunction in diabetes. *Diabet Med*. Apr; 2003 20(4):290–293. [PubMed: 12675642]
11. Baumhake M, Schlimmer N, Bohm M, Investigators D-I. Effect of irbesartan on erectile function in patients with hypertension and metabolic syndrome. *Int J Impot Res*. Sep-Oct; 2008 20(5):493–500. [PubMed: 18596705]
12. Rosenthal T, Algom M, Chagnac A, et al. Captopril as a replacement therapy in hypertension improving quality of life--a multicentre study. *Postgrad Med J*. 1986; 62(Suppl 1):114–115. [PubMed: 3317335]
13. Wassertheil-Smoller S, Blaufox MD, Oberman A, et al. Effect of antihypertensives on sexual function and quality of life: the TAIM Study.[see comment]. *Ann Intern Med*. Apr 15; 1991 114(8):613–620. [PubMed: 2003706]
14. Suzuki H, Tominaga T, Kumagai H, Saruta T. Effects of first-line antihypertensive agents on sexual function and sex hormones. *J Hypertens Suppl*. Dec; 1988 6(4):S649–651. [PubMed: 3149291]
15. Croog SH, Levine S, Sudilovsky A, Baume RM, Clive J. Sexual symptoms in hypertensive patients. A clinical trial of antihypertensive medications. *Arch Intern Med*. Apr; 1988 148(4):788–794. [PubMed: 3281619]
16. Fogari R, Zoppi A, Poletti L, Marasi G, Mugellini A, Corradi L. Sexual activity in hypertensive men treated with valsartan or carvedilol: a crossover study. *Am J Hypertens*. Jan; 2001 14(1):27–31. [PubMed: 11206674]
17. Okeahialam BN, Obeka NC. Sexual dysfunction in female hypertensives. *J Natl Med Assoc*. Apr; 2006 98(4):638–640. [PubMed: 16623078]
18. Duncan LE, Lewis C, Jenkins P, Pearson TA. Does hypertension and its pharmacotherapy affect the quality of sexual function in women? *Am J Hypertens*. Jun; 2000 13(6 Pt 1):640–647. [PubMed: 10912747]
19. Dumas M, Tsiodras S, Tsakiris A, et al. Female sexual dysfunction in essential hypertension: a common problem being uncovered. *J Hypertens*. Dec; 2006 24(12):2387–2392. [PubMed: 17082720]
20. Shifren JL, Monz BU, Russo PA, Segreti A, Johannes CB. Sexual problems and distress in United States women: prevalence and correlates. *Obstet Gynecol*. Nov; 2008 112(5):970–978. [PubMed: 18978095]
21. Patel D, Gillespie B, Foxman B. Sexual behavior of older women: results of a random-digit-dialing survey of 2,000 women in the United States. *Sex Transm Dis*. Mar; 2003 30(3):216–220. [PubMed: 12616139]
22. Addis IB, Ireland CC, Vittinghoff E, Lin F, Stuenkel CA, Hulley S. Sexual activity and function in postmenopausal women with heart disease. *Obstet Gynecol*. Jul; 2005 106(1):121–127. [PubMed: 15994626]
23. Nusbaum MR, Singh AR, Pyles AA. Sexual healthcare needs of women aged 65 and older. *J Am Geriatr Soc*. Jan; 2004 52(1):117–122. [PubMed: 14687325]
24. Lindau ST, Schumm LP, Laumann EO, Levinson W, O'Muircheartaigh CA, Waite LJ. A study of sexuality and health among older adults in the United States. *N Engl J Med*. Aug 23; 2007 357(8):762–774. [PubMed: 17715410]

25. Lindau ST, Laumann EO, Levinson W, Waite LJ. Synthesis of scientific disciplines in pursuit of health: the Interactive Biopsychosocial Model. *Perspect Biol Med.* Summer;2003 46(3 Suppl):S74–86. [PubMed: 14563076]
26. Lindau ST, Leitsch SA, Lundberg KL, Jerome J. Older women's attitudes, behavior, and communication about sex and HIV: a community-based study. *J Womens Health (Larchmt).* Jul-Aug;2006 15(6):747–753. [PubMed: 16910906]
27. Camacho ME, Reyes-Ortiz CA. Sexual dysfunction in the elderly: age or disease? *Int J Impot Res.* Dec; 2005 17(Suppl 1):S52–56. [PubMed: 16391544]
28. Fugl-Meyer AR, Lodnert G, Branholt IB, Fugl-Meyer KS. On life satisfaction in male erectile dysfunction. *Int J Impot Res.* Sep; 1997 9(3):141–148. [PubMed: 9315491]
29. Kaiser FE. Sexuality in the elderly. *Urol Clin North Am.* Feb; 1996 23(1):99–109. [PubMed: 8677540]
30. Lindau ST, Tang H, Gomero A, et al. Sexuality among middle-aged and older adults with diagnosed and undiagnosed diabetes: a national, population-based study. *Diabetes Care.* Oct; 2010 33(10):2202–2210. [PubMed: 20802158]
31. Laumann EO, Waite LJ. Sexual dysfunction among older adults: prevalence and risk factors from a nationally representative U.S. probability sample of men and women 57–85 years of age. *J Sex Med.* Oct; 2008 5(10):2300–2311. [PubMed: 18702640]
32. Vital signs: prevalence, treatment, and control of hypertension--United States, 1999–2002 and 2005–2008. *MMWR Morb Mortal Wkly Rep.* Feb 4; 2011 60(4):103–108. [PubMed: 21293325]
33. Qato DM, Alexander GC, Conti RM, Johnson M, Schumm P, Lindau ST. Use of prescription and over-the-counter medications and dietary supplements among older adults in the United States. *Jama.* Dec 24; 2008 300(24):2867–2878. [PubMed: 19109115]
34. Qato DM, Schumm LP, Johnson M, Mihai A, Lindau ST. Medication data collection and coding in a home-based survey of older adults. *J Gerontol B Psychol Sci Soc Sci.* Nov; 2009 64(Suppl 1):i86–93. [PubMed: 19491196]
35. Doulmas M, Tsakiris A, Douma S, et al. Factors affecting the increased prevalence of erectile dysfunction in Greek hypertensive compared with normotensive subjects. *J Androl.* May-Jun;2006 27(3):469–477. [PubMed: 16339456]
36. Kohout FJ, Berkman LF, Evans DA, Cornoni-Huntley J. Two shorter forms of the CES-D (Center for Epidemiological Studies Depression) depression symptoms index. *J Aging Health.* May; 1993 5(2):179–193. [PubMed: 10125443]
37. Radloff L. The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement.* 1977; 1:385–401.
38. Babyak MA. What you see may not be what you get: a brief, nontechnical introduction to overfitting in regression-type models. *Psychosom Med.* May-Jun;2004 66(3):411–421. [PubMed: 15184705]
39. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *Journal of clinical epidemiology.* Dec; 1996 49(12):1373–1379. [PubMed: 8970487]
40. Duncan LE, Lewis C, Smith CE, Jenkins P, Nichols M, Pearson TA. Sex, drugs, and hypertension: a methodological approach for studying a sensitive subject. *Int J Impot Res.* Feb; 2001 13(1):31–40. [PubMed: 11313838]
41. Jensen J, Lendorf A, Stimpel H, Frost J, Ibsen H, Rosenkilde P. The prevalence and etiology of impotence in 101 male hypertensive outpatients. *Am J Hypertens.* Mar; 1999 12(3):271–275. [PubMed: 10192229]
42. Morley JE, Tariq SH. Sexuality and disease. *Clin Geriatr Med.* Aug; 2003 19(3):563–573. [PubMed: 14567008]
43. Mechanic D. Some implications of illness behavior for medical sampling. *N Engl J Med.* Aug 1.1963 269:244–247. [PubMed: 13934329]
44. Hyde Z, Flicker L, Hankey GJ, et al. Prevalence of sexual activity and associated factors in men aged 75 to 95 years: a cohort study. *Ann Intern Med.* Dec 7; 2010 153(11):693–702. [PubMed: 21135292]

45. Cocco G. Erectile dysfunction after therapy with metoprolol: the Hawthorne effect. *Cardiology*. 2009; 112(3):174–177. [PubMed: 18654082]
46. Chang SW, Fine R, Siegel D, Chesney M, Black D, Hulley SB. The impact of diuretic therapy on reported sexual function. *Arch Intern Med*. Dec; 1991 151(12):2402–2408. [PubMed: 1746997]
47. Bohm M, Baumhakel M, Teo K, et al. Erectile dysfunction predicts cardiovascular events in high-risk patients receiving telmisartan, ramipril, or both: The ONgoing Telmisartan Alone and in combination with Ramipril Global Endpoint Trial/Telmisartan Randomized Assessment Study in ACE iNtolerant subjects with cardiovascular Disease (ONTARGET/TRANSCEND) Trials. *Circulation*. Mar 30; 121(12):1439–1446. [PubMed: 20231536]

Table 1

Characteristics of study cohort by hypertension (HTN) status

	Men (n=1255)				Women (n=1390)			
	HTN-Treated	HTN-Untreated	No HTN*	p	HTN-Treated	HTN-Untreated	No HTN*	p
	unwt n (wt%)	unwt n (wt%)	unwt n (wt%)		unwt n (wt%)	unwt n (wt%)	unwt n (wt%)	
Age	734 (56.3)	274 (22.5)	247 (21.2)	<0.001	858 (57.3)	234 (18.0)	298 (24.7)	<0.001
57-64	210 (34.1)	126 (54.6)	127 (58.5)		228 (33.2)	88 (41.0)	134 (53.1)	
65-74	308 (41.0)	93 (28.5)	76 (28.6)		302 (34.4)	80 (36.4)	110 (35.6)	
75-85	216 (24.9)	55 (16.9)	44 (12.9)		328 (32.3)	66 (22.7)	54 (11.3)	
Race/Ethnicity				0.016				0.006
White	519 (81.3)	191 (78.8)	179 (81.3)		558 (76.6)	182 (84.9)	226 (84.6)	
African American	129 (0.6)	39 (9.7)	24 (4.9)		198 (14.5)	31 (8.2)	28 (5.1)	
Hispanic	62 (5.1)	35 (7.8)	37 (10.6)		85 (6.8)	16 (4.8)	36 (8.5)	
Other	22 (3.0)	9 (3.7)	7 (3.2)		15 (2.2)	5 (2.1)	7 (1.8)	
Spousal or other intimate relationship				0.344				<0.001
Yes	590 (83.3)	228 (87.3)	211 (87.2)		413 (56.9)	128 (57.7)	189 (72.1)	
Insurance				0.058				<0.001
Private	344 (66.3)	139 (72.5)	125 (67.2)		382 (61.1)	108 (61.1)	159 (68.4)	
Medicare	166 (25.2)	51 (19.8)	49 (20.7)		205 (26.6)	49 (26.8)	64 (22.0)	
Medicaid	26 (3.2)	8 (2.2)	7 (4.3)		63 (6.6)	13 (5.1)	8 (1.8)	
Veterans Affairs	16 (2.6)	3 (0.8)	4 (3.2)		4 (0.7)	0 (0.0)	1 (0.3)	
Other	16 (2.7)	12 (4.7)	9 (4.6)		30 (5.0)	12 (7.0)	16 (7.5)	
Blood Pressure mmHg (mean, SE)**								
Systolic	140.0 (0.8)	152.2 (1.0)	122.9 (0.7)	<0.001	140.0 (0.8)	150.0 (1.1)	119.9 (0.6)	<0.001
Diastolic	80.3 (0.6)	89.4 (0.8)	76.3 (0.6)	<0.001	82.6 (0.5)	91.0 (0.6)	75.9 (0.5)	<0.001
Hypertension Stage				<0.001				<0.001
Normotensive (<120/80)	114 (15.5)	0	72 (29.1)		102 (11.9)	0	113 (37.9)	
Prehypertension (120-139/80-89)	213 (29.0)	0	175 (70.9)		282 (32.9)	0	185 (62.1)	
Stage I (140-159/90-99)	274 (37.3)	188 (68.6)	0		298 (34.7)	165 (70.5)	0	
Stage II (>=160/100)	133 (18.1)	86 (31.4)	0		176 (20.5)	69 (29.5)	0	

	Men (n=1255)			Women (n=1390)		
	HTN-Treated	HTN-Untreated	No HTN*	HTN-Treated	HTN-Untreated	No HTN*
	unwt n (wt%)	unwt n (wt%)	unwt n (wt%)	unwt n (wt%)	unwt n (wt%)	unwt n (wt%)
Undiagnosed HTN†	734 (56.3)	274 (22.5)	247 (21.2)	858 (57.3)	234 (18.0)	298 (24.7)
Yes	47 (6.0)	203 (76.5)	0	38 (5.1)	190 (82.0)	0
Currently Smoking						
Yes	111 (14.2)	54 (21.3)	45 (19.2)	99 (12.8)	36 (15.7)	52 (16.5)
Diabetes (diagnosed/undiagnosed)						
Yes	262 (34.4)	45 (14.9)	32 (13.1)	284 (31.0)	26 (10.5)	27 (7.9)
Coronary Heart Disease						
Yes	155 (20.9)	19 (10.7)	12 (4.8)	103 (10.4)	6 (2.2)	9 (3.0)
Cerebrovascular Disease						
Yes	88 (10.5)	7 (2.7)	11 (5.2)	92 (10.5)	12 (4.7)	18 (4.3)
Depression Symptoms						
Yes	153 (18.7)	43 (19.1)	46 (17.9)	249 (26.2)	57 (24.5)	67 (20.2)
Antidepressant Medication						
Yes	73 (9.4)	11 (3.9)	17 (7.8)	158 (20.3)	28 (12.7)	46 (16.8)
Functional Impairment						
Yes	52 (5.9)	4 (5.1)	3 (0.8)	76 (7.3)	8 (3.5)	16 (3.5)

* No HTN (by self-report and blood pressure measurement) and not taking antihypertensive medication

** Mean refers to the average of 2 blood pressure readings, or 3 readings if the difference between the first two systolic readings was 20mmHg, or if the diastolic readings differed by 14mmHg.

† Married, living with a partner or in a romantic relationship

Table 2

Sexual activity and problems by hypertension (HTN) status

	Men (n=1255)		p	Women (n=1390)		p
	HTN-Treated	HTN-Untreated		HTN-Treated	HTN-Untreated	
Total in each group	unwt n (wt%) 734 (56.3)	unwt n (wt%) 274 (22.5)		unwt n (wt%) 858 (57.3)	unwt n (wt%) 234 (18.0)	
Sexual Activity with Partner (Total)	427 (66.5)	197 (75.9)	0.001	247 (35.2)	83 (38.3)	<0.001
Among subjects in spousal or other intimate relationship	396 (68.0)	183 (83.4)	<0.001	237 (60.3)	81 (63.8)	<0.001
Masturbation	306 (50.9)	120 (54.3)	0.760	139 (19.7)	62 (30.4)	0.001
Any Sexual Problem*	289 (69.1)	105 (57.7)	0.007	176 (73.7)	49 (65.3)	0.301
Specific Sexual Problems*						
Lacked interest	112 (27.2)	42 (28.0)	0.861	107 (45.4)	25 (34.3)	0.134
Inability to climax	99 (22.7)	30 (15.0)	0.131	90 (33.5)	21 (25.8)	0.132
Climaxed too quickly	125 (27.6)	52 (28.1)	0.997	27 (11.4)	6 (6.6)	0.192
Pain	13 (3.1)	3 (1.2)	0.309	41 (16.0)	10 (11.2)	0.017
Not pleasurable	38 (7.8)	8 (3.1)	0.004	54 (21.7)	19 (25.6)	0.731
Anxiety about performance	135 (29.4)	35 (17.8)	0.043	35 (13.1)	6 (6.7)	0.084
Getting/maintaining erection	172 (41.2)	54 (31.1)	0.007	97 (40.3)	29 (36.3)	0.821
Lubrication				54 (22.1)	15 (14.4)	0.086
Not/Slightly Aroused [†]				21 (13.0)	7 (11.9)	0.304
No/Slight Tingling [†]						
Partnered sexual activity (OR, 95% CI)						
Unadjusted	0.61 (0.41–0.91)	1.26 (0.85–1.87)	1.00	0.39 (0.29–0.54)	0.45 (0.30–0.67)	1.00
Adjusted [‡]	0.86 (0.51–1.45)	1.45 (0.79–2.65)	1.00	0.61 (0.39–0.95)	0.54 (0.30–0.96)	1.00
Sexual problems (OR, 95% CI)						
Unadjusted	1.88 (1.30–2.73)	1.14 (0.73–1.80)	1.00	1.11 (0.64–1.91)	0.74 (0.39–1.40)	1.00
Adjusted [‡]	1.49 (0.94–2.37)	1.10 (0.63–1.90)	1.00	0.82 (0.44–1.54)	0.63 (0.31–1.29)	1.00

* Elicited among adults who are sexually active with a partner

[†] As compared to moderate/very/extremely

Table 3

Frequency of sexual activity and sexual problems among adults treated for hypertension by antihypertensive medication class

		Sexually Active		Sexual problems among sexually active		
	N	n(%)	p value	N*	n(%)	p value
Men (N=734)						
Calcium Channel Blocker						
Yes	241	139 (57.8)	0.375	134	97 (71.5)	0.550
No	493	288 (61.7)		278	192 (68.1)	
Beta-blocker						
Yes	324	175 (55.5)	0.030	168	119 (70.7)	0.684
No	410	252 (64.4)		244	170 (68.1)	
ACEi/ARB						
Yes	487	285 (61.5)	0.562	276	190 (68.0)	0.418
No	247	142 (58.7)		136	99 (71.5)	
Diuretic						
Yes	301	162 (55.3)	0.029	155	116 (73.4)	0.315
No	433	265 (64.2)		257	173 (66.5)	
Alpha blocker						
Yes	141	78 (54.0)	0.159	76	53 (70.8)	0.741
No	593	349 (62.1)		336	236 (68.8)	
Women (N=858)						
Calcium Channel Blocker						
Yes	275	68 (30.0)	0.121	65	50 (75.5)	0.771
No	583	179 (37.2)		168	126 (73.1)	
Beta-blocker						
Yes	338	94 (35.5)	0.912	87	64 (68.5)	0.263
No	520	153 (35.0)		146	112 (77.0)	
ACEi/ARB						
Yes	525	142 (32.5)	0.177	134	102 (73.7)	0.995
No	333	105 (39.6)		99	74 (73.7)	

	Sexually Active		Sexual problems among sexually active		
	N	n(%)	p value	N*	n(%)
Diuretic					
Yes	432	114 (32.4)	0.19	109	83 (76.0)
No	426	133 (37.9)		124	93 (71.8)
Alpha blocker					
Yes	40	10 (25.5)	0.251	9	6 (65.8)
No	818	237 (35.6)		224	170 (73.9)

* May not sum to number who are sexually active due to missing values

Table 4

Association between antihypertensive medication class and sexual activity

Men					
	Unadjusted OR (95% CI)	p value	Model 1 OR (95% CI)	p value	Model 2 OR (95% CI)
CCB	0.85 (0.59–1.23)	0.38	0.81 (0.55–1.17)	0.25	1.00 (0.63–1.61)
BB	0.69 (0.50–0.96)	0.03	0.68 (0.48–0.96)	0.03	0.84 (0.52–1.36)
ACEi/ARB	1.12 (0.76–1.65)	0.56	1.03 (0.70–1.51)	0.88	1.09 (0.62–1.91)
Diuretics	0.69 (0.50–0.96)	0.03	0.70 (0.50–0.98)	0.04	0.78 (0.49–1.24)
Alpha	0.72 (0.46–1.11)	0.13	0.74 (0.49–1.13)	0.16	1.20 (0.74–1.97)

Women					
	Unadjusted OR (95% CI)	p value	Model 1 OR (95% CI)	p value	Model 2 OR (95% CI)
CCB	0.72 (0.47–1.11)	0.13	0.67 (0.44–1.01)	0.06	0.74 (0.40–1.36)
BB	1.02 (0.70–1.48)	0.91	0.90 (0.62–1.32)	0.59	0.86 (0.51–1.46)
ACEi/ARB	0.73 (0.47–1.15)	0.18	0.68 (0.43–1.05)	0.08	0.62 (0.33–1.13)
Diuretics	0.79 (0.54–1.14)	0.20	0.73 (0.51–1.07)	0.10	0.59 (0.38–0.92)
Alpha	0.62 (0.26–1.45)	0.26	0.65 (0.25–1.66)	0.36	0.90 (0.34–2.38)

Model 1: adjusted for other antihypertensive medication classes

Model 2: adjusted for Model 1 + sociodemographic characteristics (age, relationship status, and insurance status) and clinical characteristics (diabetes, coronary heart disease, smoking, functional status, and depression)

Table 5
Association between antihypertensive medication class and experiencing any sexual problem

Men					
	Unadjusted OR (95% CI)	p value	Model 1 OR (95% CI)	p value	Model 2 OR (95% CI)
CCB	1.17 (0.68–2.02)	0.55	1.21 (0.66–2.20)	0.53	1.36 (0.63–2.93)
BB	1.13 (0.62–2.07)	0.69	1.14 (0.60–2.18)	0.68	0.85 (0.43–1.66)
ACEi/ARB	0.85 (0.56–1.28)	0.42	0.86 (0.57–1.29)	0.46	0.53 (0.30–0.93)
Diuretics	1.39 (0.72–2.68)	0.32	1.41 (0.73–2.70)	0.30	1.64 (0.82–3.31)
Alpha	1.10 (0.62–1.97)	0.74	1.08 (0.61–1.91)	0.79	1.08 (0.54–2.15)

Women					
	Unadjusted OR (95% CI)	p value	Model 1 OR (95% CI)	p value	Model 2 OR (95% CI)
CCB	1.13 (0.48–2.67)	0.77	1.09 (0.47–2.56)	0.84	1.67 (0.49–5.75)
BB	0.65 (0.31–1.35)	0.24	0.65 (0.31–1.39)	0.26	0.76 (0.31–1.89)
ACEi/ARB	1.00 (0.44–2.26)	0.10	0.96 (0.41–2.24)	0.92	1.18 (0.48–2.91)
Diuretics	1.24 (0.59–2.60)	0.56	1.27 (0.59–2.74)	0.53	1.17 (0.51–2.73)
Alpha	0.68 (0.13–3.65)	0.64	0.66 (0.11–4.10)	0.65	2.06 (0.25–16.65)

Model 1: adjusted for other antihypertensive medication classes

Model 2: adjusted for Model 1 + sociodemographic characteristics (age, relationship status, and insurance status) and clinical characteristics (diabetes, coronary heart disease, smoking, functional status, and depression)