

Factors Associated With Physician Recommendation of Home Blood Pressure Monitoring and Blood Pressure in the US Population

Olive Tang,¹⁻³ Kathryn Foti,^{2,3} Edgar R. Miller III,¹⁻³ Lawrence J. Appel,^{1-3,6} and Stephen P. Juraschek^{4,5,6}

BACKGROUND

Hypertension guidelines recommend home blood pressure monitoring (HBPM) to help achieve blood pressure (BP) control. We hypothesized that HBPM use with a physician recommendation would be associated with lower BP and greater medication adherence.

METHODS

We used data from 6,320 adults with hypertension in the National Health and Nutrition Examination Survey 2009–2014 to characterize the association of (i) provider recommendation for HBPM and (ii) HBPM use on 2 outcomes: measured BP (linear regression) and medication adherence (logistic regression). Provider recommendation, HBPM use, and medication use were self-reported.

RESULTS

Among adults with hypertension, 30.1% reported a physician recommendation for HBPM, among whom 82.0% reported using HBPM. Among those who did not report a physician recommendation for HBPM, 28.3% used HBPM. Factors associated with a physician

recommendation were having health insurance, higher education attainment, hypertension awareness, and having a prescription for antihypertensive medication. Among those who reported receiving a physician recommendation, those who used HBPM had a mean BP that was 3.1/4.5 mm Hg lower than those who did not. Those who reported having a physician recommendation and using HBPM were more likely to report hypertension medication adherence (odds ratio 2.9; 95% confidence interval: 2.0, 4.4).

CONCLUSIONS

HBPM use was associated with lower BP and higher medication adherence. Use of HBPM was higher among those with a physician recommendation. These results support a role for physicians in counseling and partnering with patients on HBPM use for BP management.

Keywords: blood pressure; home blood pressure monitoring; hypertension; NHANES

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Accurate blood pressure (BP) measurement is a critical component of hypertension treatment and management. While BP measured in clinic office settings have conventionally dictated treatment decisions, there is growing evidence that the quality and accuracy of clinic-based measurements varies substantially.¹⁻³ Because of these concerns, professional societies and practice guidelines, both in the United States⁴⁻⁷ and abroad,^{8,9} increasingly advocate for the use of home blood pressure monitoring (HBPM) to assist in the diagnosis and management of hypertension. These recommendations are based on clinical trials showing a short-term benefit of HBPM in lowering BP¹⁰ and improving patient engagement with treatment.⁵ Larger effects on BP lowering have been observed when HBPM was coupled with clinical action such as medication titration,¹¹ highlighting the complementary roles of the health provider and patient in HBPM use and interpretation.

Prior studies in US adults have assessed population characteristics associated with HBPM, and found that a physician recommendation for HBPM was more common among HBPM users compared with those who did not report using HBPM.^{12,13} Furthermore, US adults using HBPM were more likely to have diagnosed, treated, or controlled hypertension.^{12,13} Complementing HBPM with additional clinician support has been shown to have a more robust impact on BP control compared with HBPM alone.¹⁴ Therefore, we assessed whether having a physician recommendation modified the association of HBPM and measured BP or self-reported medication use among US adults with hypertension.

The objectives of our study are (i) to characterize sociodemographic and clinical factors associated with self-reported HBPM and physician recommendation for HBPM and (ii) to assess the associations of HBPM and physician

Correspondence: Stephen P. Juraschek (sjurasch@bidmc.harvard.edu).

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¹Department of Medicine, The Johns Hopkins School of Medicine, Baltimore, Maryland, USA; ²Department of Epidemiology, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; ³The Welch Center for Prevention, Epidemiology and Clinical Research, Johns Hopkins University, Baltimore, Maryland, USA; ⁴Department of Medicine, Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA; ⁵Harvard Medical School, Boston, Massachusetts, USA.

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recommendation with measured BP and medication use among those who recalled having been told to take BP lowering medication. We hypothesized that physicians would be more likely to recommend HBPM to higher risk patients (e.g., older, with comorbidities), and that HBPM use would be associated with lower BP and higher medication adherence, particularly among those who reported a physician recommendation for HBPM.

METHODS

Study population

The continuous National Health and Nutrition Examination Survey (NHANES) 2009–2014 are a program of surveys, conducted by the National Center for Health Statistics over 3, 2-year cycles. The NHANES employ a multistage sampling approach to select a nationally representative sample of participants. In these 3 survey cycles, a total of 17,547 adults over the age of 20 underwent a home interview, physical examination, and laboratory testing. Hypertension status was defined by a self-report of a prior diagnosis of hypertension ($N = 6,426$) or a systolic BP ≥ 140 or diastolic BP ≥ 90 mm Hg at the NHANES examination without a prior diagnosis ($N = 968$). We excluded participants who self-reported being pregnant or who had a positive lab pregnancy test.^{15–17} Among this population of nonpregnant adults with hypertension, complete data were available for 6,366 participants, who comprised our analytic population.

Definition of main exposure

Provider recommendation and HBPM use were self-reported in response to the questions “Did a doctor tell you to take your blood pressure at home? (yes/no)” and “Did you take your blood pressure at home during the past 12 months? (yes/no),” respectively.^{18–20}

Outcome definitions

All systolic and diastolic BP measurements were obtained at the NHANES mobile examination clinic by trained physicians using calibrated mercury sphygmomanometers. Participants were asked to rest for 5 minutes, after which their maximum inflation level was determined and triplicate measurements were made, separated by 30 seconds each.²¹ Mean BP was defined based on an average of up to 3 BP measurements at the NHANES examination visit. Hypotension status was defined as a mean BP $< 90/60$ mm Hg.²²

A subgroup of 4,637 participants self-reported ever having been told to take prescription medication for high BP, based on a “yes” response to the question, “Because of your (high BP/hypertension), you ever been told to take prescribed medicine?” Among this subgroup, antihypertensive medication adherence was defined based on a “yes” response to the question, “Are you now taking prescribed medication?”^{18–20}

Covariate definitions

Age was modeled categorically in 10-year intervals from 20 to 80+ years. Race was self-reported and classified

as non-Hispanic White, non-Hispanic Black, Mexican American, non-Mexican Hispanic, and Other (includes non-Hispanic Asians, who were oversampled starting in 2011). We examined the following additional self-reported factors: marital status (single, never married; married/living with partner; widowed/divorced/separated), current smoking status (yes/no), education (less than high school, high school/General Education Development, some college, beyond college), income–poverty ratio (not in poverty, > 1.3 , borderline poverty, $1.0–1.3$, poverty, < 1.0 ; 7.2% were unknown), having health insurance (yes, no), having a usual health care site (yes, no), and diabetes status (yes, no). Stage 3–5 chronic kidney disease (CKD) status was defined as an estimated glomerular filtration rate of < 60 ml/min/1.73 m², calculated using the Chronic Kidney Disease Epidemiology Collaboration equation²³ based on laboratory standardized creatinine measurements. Hypertension duration was derived based on the difference between participant age at the NHANES visit and self-reported age at hypertension diagnosis. Those detected at the examination were assigned a duration of 0 years. Frequency of HBPM was based on self-report in response to the question: “How often did you check blood pressure at home during the last 12 months?”^{18–20} and categorized as following: less than monthly (< 12), monthly to weekly (12 to < 52), weekly to daily (52 to < 365), and more than once a day (≥ 365).

Statistical analysis

The NHANES mobile examination clinic weights were used to account for the multilevel survey design and participant nonresponse. Variance was estimated using Taylor series linearization. Multivariable linear regression was used in analyses with systolic or diastolic BP as the outcome. Multivariable logistic regression was used to model current medication use among the subset of participants who reported ever having been told to take prescription medication. Models were unadjusted (Model 0), adjusted for age, sex, and race (Model 1), and additionally adjusted for income:poverty ratio, education, marital status, current smoking, body mass index category, insurance, having a regular healthcare site, self-reported health, diagnosed diabetes, diagnosed hypertension, stage 3–5 CKD, and hypertension duration (Model 2). Interactions between HBPM and having received a doctor’s recommendation were assessed using Wald’s test of the interaction term and the following categories: (i) Using HBPM and reporting a doctor’s recommendation; (ii) using HBPM and not reporting a doctor’s recommendation; (iii) not using HBPM and reporting a doctor’s recommendation; and (iv) not using HBPM and not reporting a doctor’s recommendation. All analyses were conducted using the survey package in Stata 15.1 (College Station, TX).²⁴

RESULTS

Among US adults over the age of 20 with hypertension and with complete demographic and socioeconomic data, 30.1% reported receiving a physician recommendation for HBPM, among whom 82.0% of this group reported performing

Table 1. Characteristics of US adults with hypertension by self-reported home blood pressure monitoring status

Characteristic	Unweighted N overall	Overall	Use home blood pressure monitoring		Do not use home blood pressure monitoring	
			Doctor recommendation	No recommendation	Doctor recommendation	No recommendation
Unweighted N		6,366	1,542	1,242	346	3,236
Weighted N		76,120,230	18,857,590	15,143,959	4,175,825	37,942,857
Age, weighted %						
20–29	244	4.8	2.0	3.4	3.9	6.9
30–39	533	9.3	7.5	6.0	10.2	11.4
40–49	879	15.8	15.7	12.1	20.0	16.9
50–59	1,224	23.5	21.0	22.0	25.2	25.1
60–69	1,624	22.3	21.9	26.0	21.0	21.1
70–79	1,151	15.1	20.2	20.3	12.2	10.9
80+	711	9.2	11.7	10.2	7.5	7.8
Female, weighted %	3,190	50.6	55.1	51.7	50.3	47.9
Race, weighted %						
Non-Hispanic White	2,815	69.7	72.1	72.9	65.2	67.8
Non-Hispanic Black	1,707	14.1	13.6	12.8	17.7	14.4
Mexican American	723	5.8	4.5	3.5	5.6	7.4
Non-Mexican Hispanic	550	4.4	3.5	3.5	5.1	5.1
Other	571	6.0	6.3	7.3	6.4	5.3
Education, weighted %						
Less than high school	1,811	19.6	17.4	17.9	21.2	21.2
High school/GED	1,550	24.2	23.0	24.1	23.1	25.0
Some college	1,817	31.8	31.4	34.3	29.4	31.4
Beyond college	1,188	24.3	28.2	23.7	26.3	22.5
BMI, weighted %						
<25	1,258	18.5	18.7	19.0	14.3	18.6
25–30	2,037	32.3	30.8	35.2	27.6	32.3
30+	3,071	49.3	50.6	45.8	58.1	49.1
Hypertension awareness, weighted %	5,440	85.6	97.5	86.4	93.3	78.5
Antihypertensive prescription, weighted %	4,685	72.0	92.6	76.6	82.7	58.7
Income–poverty ratio, weighted %						
Not in poverty (>1.3)	3,790	71.3	74.7	74.2	70.4	68.5
Borderline poverty (1.0–1.3)	722	8.2	6.7	6.7	11.6	9.3
Poverty (<1.0)	1,321	13.8	11.4	12.1	14.5	15.7
Unknown	533	6.7	7.2	7.0	3.6	6.6
Current smoker, weighted %	1,422	22.0	16.3	21.9	23.7	24.7
Any health insurance, weighted %	5,353	87.2	92.9	88.6	88.2	83.7
Have regular health site, weighted %	5,803	91.9	97.3	93.0	93.0	88.6
Self-reported health status, weighted %						
Excellent/very good	1,745	34.5	31.1	35.9	28.7	36.2
Very good	2,465	39.0	40.3	38.4	37.8	38.8
Fair/poor	2,156	26.5	28.6	25.7	33.5	25.0

Table 1. Continued

Characteristic	Unweighted N overall	Overall	Use home blood pressure monitoring		Do not use home blood pressure monitoring	
			Doctor recommendation	No recommendation	Doctor recommendation	No recommendation
Marital status, weighted %						
Single, never married	742	11.0	6.4	7.8	13.0	14.4
Married, living with partner	3,647	62.7	68.1	68.1	57.7	58.5
Widowed, divorced, separated	1,977	26.2	25.5	24.1	29.3	27.1
Self-reported diabetes, weighted %	1,453	19.1	24.5	17.9	21.3	16.7
Stage 3–5 chronic kidney disease, weighted %	1,019	14.1	18.1	16.3	14.7	11.2
Hypertension duration, mean (SE) years	6,366	9.6 (0.2)	11.8 (0.3)	10.1 (0.4)	10.6 (0.7)	8.1 (0.2)
Frequency of HBPM, weighted %						
Less than monthly	4,128	65.5	13.4	29.6	—	—
Monthly to weekly	793	13.9	27.8	34.1	—	—
Weekly to daily	864	12.6	33.4	25.6	—	—
At least daily	581	8.0	25.4	10.7	—	—

Abbreviations: BMI, body mass index; GED, General Education Development; HBPM, home blood pressure monitoring.

HBPM at least once in the past year. Of the 70.2% who did not report receiving a recommendation for HBPM, 28.3% reported HBPM use at least once in the past year. Several demographic and socioeconomic factors differed among subgroups defined by having a physician recommendation and HBPM use, including age, body mass index, having a regular healthcare site, self-reported diabetes status, and hypertension duration (Table 1).

The following sociodemographic and clinical factors were independently associated with HBPM: age, non-Hispanic Black race, income:poverty ratio, education status, and self-reported having a prescription for antihypertensive medications (Supplementary Table S1 online). Meanwhile, having insurance (odds ratio (OR) 1.3; 95% confidence interval (CI): 1.1, 1.7), higher educational attainment (beyond college OR 1.5; 95% CI: 1.2, 1.9), hypertension awareness (OR 2.0; 95% CI: 1.3, 3.2), and having a prescription for antihypertensive medication (OR 3.8; 95% CI: 2.8, 5.3) were independently associated with having received a physician recommendation for HBPM (Table 2). With adjustment for demographic characteristics, those with diabetes were more likely to report having received a recommendation for HBPM (OR 1.5; 95% CI 1.3, 1.7), but those with CKD (OR 1.2; 95% CI 1.0, 1.5) did not (Table 2, Model 1). Neither remained associated with reported HBPM recommendation with adjustment for other covariates (Table 2, Model 2).

Among those who did not report receiving a physician recommendation for HBPM, HBPM use was not associated with a difference in systolic BP (1.2 mm Hg; 95% CI: -0.7, 3.2), but was associated with lower diastolic BP (-2.0 mm Hg; 95% CI: -3.6, -0.6). Among those who reported a physician recommendation, HBPM was associated with a lower systolic (-3.1 mm Hg; 95% CI: -5.7, -0.5) and diastolic (-4.5 mm Hg;

-6.2, -2.8) BP (Figure 1). Compared with those who did not use HBPM and did not recall a physician recommendation for HBPM, those with a recommendation, who did not report HBPM use had a higher average BP, even after adjustment for demographic and health characteristics (Table 3). However, those who received a recommendation and engaged in HBPM did not have a significant difference in measured BP compared with those who did not use HBPM and did not recall a physician recommendation for HBPM (Table 3). The prevalence of hypotension was rare (0.4%; 95% CI: 0.2%, 0.7%) and was not associated with either HBPM (crude OR 1.5; 95% CI: 0.5, 4.9) or having a doctor's recommendation for HBPM (crude OR 1.1; 95% CI: 0.3, 4.3).

Among those who reported ever having been told to take an antihypertensive prescription ($N = 4,685$), those who received a physician recommendation and used HBPM were more likely to report currently taking BP medications (OR 2.9; 95% CI: 2.0, 4.4). Those who received a physician recommendation but did not use HBPM were not more likely to report medication use (OR 1.1; 95% CI: 0.6, 2.0), while those who used HBPM without a physician recommendation were modestly more likely to use medications (OR 1.5; 95% CI: 1.0, 2.1) (Figure 2; Model 2).

In our large, representative study of US adults with hypertension, we characterized the relationship between HBPM use and physician recommendations for HBPM with lower BP and antihypertensive medication use. Most US adults in NHANES 2011–2014 with hypertension did not report using HBPM and did not report a physician recommendation for HBPM use. Among the population who have been recommended for HBPM, HBPM use was associated with lower systolic and diastolic BP and a higher odds of self-reported antihypertensive medication use.

Table 2. Odds ratio (95% CI) of factors associated with receiving a physician recommendation for home blood pressure monitoring, unweighted $N = 6,366$

Factor	Unadjusted	Model 1 ^a	Model 2 ^b
Age			
20–29	REF	REF	REF
30–39	2.0 (1.1, 3.6)*	2.0 (1.1, 3.7)*	1.1 (0.6, 2.1)
40–49	2.7 (1.5, 4.6)**	2.6 (1.5, 4.6)**	1.1 (0.6, 1.9)
50–59	2.3 (1.3, 3.8)**	2.2 (1.3, 3.7)**	0.8 (0.4, 1.4)
60–69	2.4 (1.5, 4.1)**	2.4 (1.4, 4.0)**	0.7 (0.4, 1.4)
70–79	3.5 (2.0, 6.0)***	3.3 (1.9, 5.8)***	1.0 (0.5, 1.9)
80+	3.2 (1.9, 5.5)***	3.1 (1.8, 5.2)***	0.9 (0.5, 1.8)
Female	1.2 (1.0, 1.5)*	1.2 (1.0, 1.4)*	1.1 (0.9, 1.3)
Race/ethnicity			
Non-Hispanic White	REF	REF	REF
Non-Hispanic Black	1.0 (0.8, 1.2)	1.1 (0.9, 1.3)	1.1 (0.9, 1.3)
Mexican American	0.7 (0.5, 1.0)	0.8 (0.6, 1.1)	0.9 (0.7, 1.3)
Non-Mexican Hispanic	0.8 (0.6, 1.1)	0.8 (0.6, 1.1)	0.9 (0.7, 1.2)
Other	1.1 (0.7, 1.5)	1.1 (0.8, 1.6)	1.2 (0.8, 1.7)
Have insurance	2.0 (1.7, 2.4)***	1.8 (1.5, 2.2)***	1.3 (1.1, 1.7)**
Have regular health site	3.1 (2.2, 4.5)***	2.6 (1.8, 3.8)***	1.5 (1.0, 2.3)
Income–poverty ratio			
Not in poverty (>1.3)	REF	REF	REF
Borderline poverty (1.0–1.3)	0.8 (0.7, 1.0)	0.8 (0.7, 1.0)	0.9 (0.8, 1.2)
Poverty (<1.0)	0.8 (0.6, 0.9)**	0.8 (0.7, 1.0)*	0.9 (0.7, 1.2)
Unknown	0.9 (0.7, 1.3)	0.9 (0.6, 1.3)	0.9 (0.7, 1.3)
Marital status			
Single, never married	REF	REF	REF
Married, living with partner	1.8 (1.2, 2.6)**	1.5 (1.1, 2.3)*	1.4 (1.0, 2.1)
Widowed, divorced, separated	1.6 (1.2, 2.4)**	1.3 (0.9, 1.8)	1.2 (0.9, 1.7)
Education			
Less than high school	REF	REF	REF
High school/GED	1.0 (0.8, 1.3)	1.1 (0.8, 1.3)	1.1 (0.9, 1.3)
Some college	1.1 (0.9, 1.3)	1.1 (0.9, 1.4)	1.1 (0.9, 1.4)
Beyond college	1.4 (1.1, 1.7)**	1.5 (1.2, 1.8)**	1.5 (1.2, 1.9)**
Current smoker	0.7 (0.6, 0.8)***	0.7 (0.6, 0.9)**	0.8 (0.7, 1.0)
BMI			
<25	REF	REF	REF
25–30	1.0 (0.8, 1.2)	1.0 (0.8, 1.2)	0.8 (0.6, 1.0)
30+	1.1 (0.9, 1.4)	1.2 (1.0, 1.5)	0.9 (0.7, 1.1)
Self-reported health			
Excellent/very good	REF	REF	REF
Good	1.2 (1.0, 1.5)	1.2 (1.0, 1.5)	1.2 (0.9, 1.5)
Fair/poor	1.4 (1.1, 1.7)**	1.4 (1.1, 1.7)**	1.3 (1.0, 1.7)
Self-reported diabetes	1.5 (1.3, 1.8)***	1.5 (1.3, 1.7)***	1.2 (1.0, 1.4)
Self-reported diagnosed hypertension	7.1 (5.0, 10.0)***	6.9 (4.9, 9.8)***	2.0 (1.3, 3.2)**
Prescription for hypertension medication	5.6 (4.5, 7.0)***	5.7 (4.4, 7.5)***	3.8 (2.8, 5.3)***
Stage 3–5 chronic kidney disease	1.5 (1.2, 1.8)***	1.2 (1.0, 1.5)	1.1 (0.9, 1.3)
Hypertension duration, per 5 years	1.1 (1.1, 1.2)***	1.1 (1.1, 1.1)***	1.0 (1.0, 1.0)

Abbreviations: BMI, body mass index; CI, confidence interval; GED, General Education Development.

^aAdjusted for age, sex, and race/ethnicity.^bAdjusted for all covariates.* $P < 0.05$.** $P < 0.01$.*** $P < 0.001$.

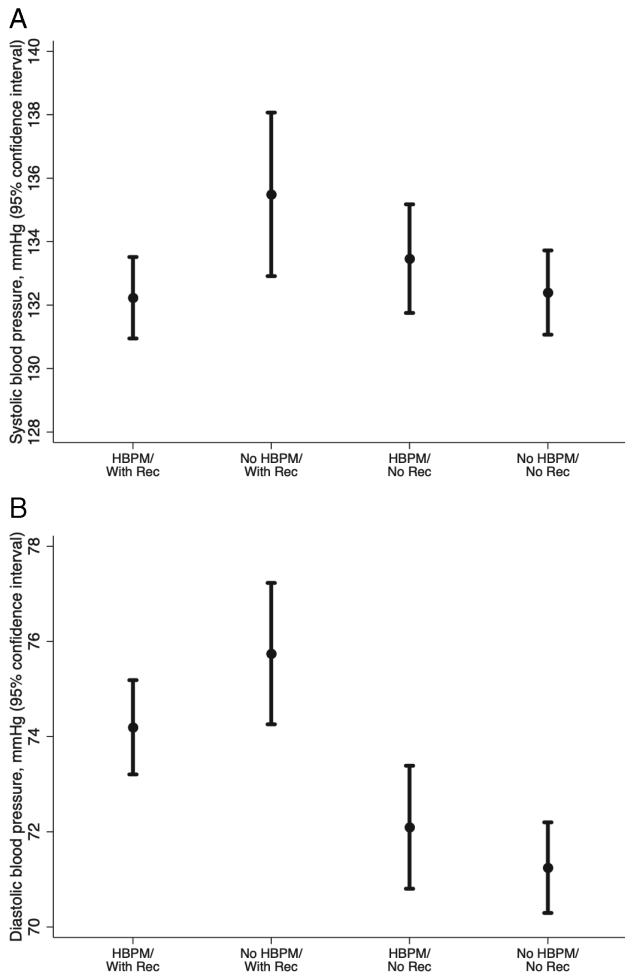


Figure 1. Mean (a) systolic and (b) diastolic blood pressure (mm Hg) by home blood pressure monitoring (HBPM) and physician recommendation status.

Physician recommendation plays an important role in HBPM use. We observed that over half of adults with hypertension who had a physician recommendation for HBPM used HBPM. However, only 30% of all US adults with hypertension had a recommendation for HBPM. Having health insurance, a college education, a hypertension diagnosis, or hypertension treatment were associated with being recommended for HBPM regardless of demographic characteristics, suggesting that a lack of healthcare access may be a barrier for HBPM recommendations. Other barriers that were not assessed in NHANES (e.g., the cost of devices, insurance coverage and reimbursement for HBPM) should be explored in subsequent studies.

Our findings build upon a prior analysis of the full NHANES population, which showed an association of HBPM with age, race, hypertension awareness, diabetes status, and hypertension control.¹³ Here, we focused on adults with hypertension and assessed whether the relationship between HBPM and measured BP was modified by receiving a physician recommendation for HBPM use. Our findings are consistent with prior studies showing a greater reduction in BP among patients who monitor their BP at home,^{11,25} and with prior studies

Table 3. Differences in mean measured blood pressure among participants based on use home blood pressure monitoring and recall of physician recommendation for home blood pressure monitoring

Outcome	Unadjusted	Model 1	Model 2
SBP, β (95% CI)	6,366		
No physician recommendation/no HBPM	0 (reference)	0 (reference)	0 (reference)
No physician recommendation/HBPM	1.2 (-0.7, 3.2)	0.0 (-2.0, 2.0)	1.7 (0.1, 3.3)
Physician recommendation/no HBPM	3.3 (0.8, 5.7)	3.0 (0.7, 5.3)	6.3 (4.3, 8.3)
Physician recommendation/HBPM	0.2 (-1.2, 1.6)	-1.1 (-2.5, 0.4)	3.1 (1.7, 4.5)
Interaction term <i>P</i> value	0.009	0.013	0.001
DBP, β (95% CI)	6,366		
No physician recommendation/no HBPM	0 (reference)	0 (reference)	0 (reference)
No physician recommendation/HBPM	-2.1 (-3.6, -0.6)	-0.3 (-1.6, 1.0)	0.4 (-0.9, 1.6)
Physician recommendation/no HBPM	1.5 (0.1, 3.0)	1.5 (0.1, 3.0)	3.1 (1.7, 4.4)
Physician recommendation/HBPM	-2.9 (-4.0, -1.9)	-1.3 (-2.3, -0.3)	0.6 (-0.3, 1.5)
Interaction term <i>P</i> value	0.014	0.006	0.002

Model 1: adjusted for age, sex, and race. Model 2: Model 1 + income:poverty ratio, education, marital status, current smoking, BMI category, insurance, having a regular healthcare site, self-reported health, diagnosed diabetes, diagnosed hypertension, stage 3–5 chronic kidney disease, and hypertension duration. Abbreviations: BMI, body mass index; CI, confidence interval; DBP, diastolic blood pressure; HBPM, home blood pressure monitoring; SBP, systolic blood pressure.

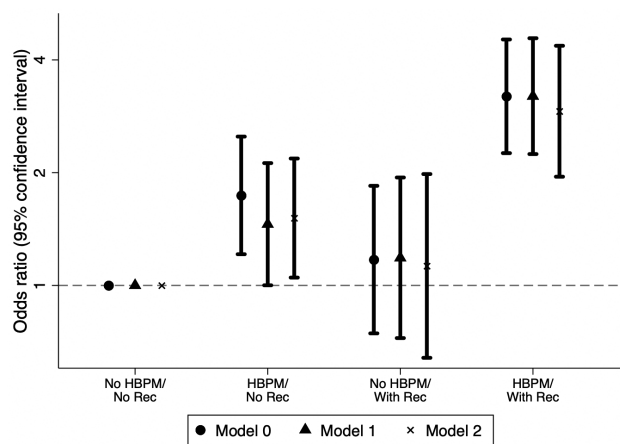


Figure 2. Association of hypertension medication use (yes vs. no) in past 12 months with home blood pressure monitoring and physician recommendation for home monitoring among 4,637 participants with a self-reported prescription for hypertension medication. Model 1 was adjusted for age, sex, and race. Model 2 includes additional adjustment for income–poverty ratio categories, educational attainment, marital status, current smoking status, BMI categories, having insurance, having a regular health site, self-reported health category, self-reported diabetes, self-reported hypertension, self-reported prescription for hypertension medication, stage 3–5 chronic kidney disease, and hypertension duration. Abbreviation: HBPM, home blood pressure monitoring.

suggesting that home monitoring, even in the absence of coupled interventions such as medication titration programs, may be associated with slower decline in medication adherence compared with those who do not self-monitor.²⁶ Our findings show these associations may be applicable to adults with hypertension.

Despite the literature supporting the benefits of home monitoring, this resource may be underutilized, both broadly, as most US adults with hypertension did not report being recommended by their physician to home monitor and did not engage in monitoring, and in high-risk subpopulations, such as those with kidney disease.²⁷ While we observed higher rates of home monitoring among patients with diabetes compared with those without, this association was not seen among CKD patients. This may be partly due to the objective measure of creatinine used to define CKD status as CKD awareness is thought to be low in the United States.²⁸ However, this is consistent with a study of CKD patients by Ye *et al.* which found the most common reason for not using HBPM was the lack of a recommendation to do so.²⁹ A meta-analysis of prevalence estimates for masked and white coat hypertension in the CKD population suggests that about 40% of those with controlled clinic BP had uncontrolled BP at home, and 30% of those with uncontrolled BP in the clinic were controlled at home, highlighting the substantial discordance of home BP with clinic BP in this population.³⁰ Our findings suggest there may be under-recommendation of HBPM in the CKD population.

There are several limitations to our analyses. Given the cross-sectional nature of NHANES, we are unable to comment on the temporality of the exposure and outcomes. It is possible that HBPM may contribute to improved BP control and medication use. Alternatively, we cannot rule out that

those with better controlled hypertension or higher medication adherence might be more likely to engage in HBPM. Second, doctors may be selective in their recommendations for HBPM use. Indeed, we observed and controlled for potential confounders such as hypertension duration, diabetes status, and health care access which were differentially associated with self-reported doctor recommendation. However, there may also be unmeasured confounders such as a doctor's perception of the compliance of the patient, which may also factor into their willingness to recommend this practice to their patients. This is consistent with the higher medication use among those who received a physician recommendation for home monitoring. Thus, whether providing a recommendation to a broader patient population will have similar effects remains to be seen. Third, our main exposures and covariates of interest were self-reported, and thus susceptible to misclassification. For example, some adults may not recall a diagnosis of hypertension. Finally, with the available data, we are unable to assess how participants were using HBPM and whether participants changed their hypertension management strategies (e.g., titration of medication) as a result of their monitoring. However, this is certainly possible given the higher prevalence of antihypertensive medications among adults using HBPM.

In conclusion, HBPM is associated with lower average BP and higher antihypertensive medication use among adults with hypertension, particularly among those who received a physician's recommendation for HBPM. Despite the potential benefits of this practice, most adults with hypertension do not use HBPM and have not been told to do so by their physicians. Barriers to receiving a physician recommendation (e.g., health disparities and insurance status) represent an important area for further intervention to improve both physician recommendation and patient uptake of HBPM.

SUPPLEMENTARY MATERIAL

Supplementary data are available at *American Journal of Hypertension* online.

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DISCLOSURE

The authors declared no conflict of interest.

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