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Magnitude of the Difference Between Clinic and Ambulatory Blood Pressures and Risk of Adverse Outcomes in Patients With Chronic Kidney Disease

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Background—Obtaining 24-hour ambulatory blood pressure (BP) is recommended for the detection of masked or white-coat hypertension. Our objective was to determine whether the magnitude of the difference between ambulatory and clinic BPs has prognostic implications.

Methods and Results—We included 610 participants of the AASK (African American Study of Kidney Disease and Hypertension) Cohort Study who had clinic and ambulatory BPs performed in close proximity in time. We used Cox models to determine the association between the absolute systolic BP (SBP) difference between clinic and awake ambulatory BPs (primary predictor) and death and end-stage renal disease. Of 610 AASK Cohort Study participants, 200 (32.8%) died during a median follow-up of 9.9 years; 178 (29.2%) developed end-stage renal disease. There was a U-shaped association between the clinic and ambulatory SBP difference with risk of death, but not end-stage renal disease. A 5– to <10–mm Hg higher clinic versus awake SBP (white-coat effect) was associated with a trend toward higher (adjusted) mortality risk (adjusted hazard ratio, 1.84; 95% CI, 0.94–3.56) compared with a 0– to <5–mm Hg clinic-awake SBP difference (reference group). A ≥10–mm Hg clinic-awake SBP difference was associated with even higher mortality risk (adjusted hazard ratio, 2.31; 95% CI, 1.27–4.22). A ≥−5–mm Hg clinic-awake SBP difference was also associated with higher mortality (adjusted hazard ratio, 1.82; 95% CI, 1.05–3.15) compared with the reference group.

Conclusions—A U-shaped association exists between the magnitude of the difference between clinic and ambulatory SBP and mortality. Higher clinic versus ambulatory BPs (as in white-coat effect) may be associated with higher risk of death in black patients with chronic kidney disease. (*J Am Heart Assoc*. 2019;8:e011013. DOI: 10.1161/JAHA.118.011013.)

Key Words: ambulatory blood pressure monitoring • chronic kidney disease • end-stage renal disease • hypertension • mortality

Several current guidelines recommend use of ambulatory blood pressure monitoring (ABPM) as the gold standard metric for the diagnosis and confirmation of hypertension in adults.[1–3] This recommendation stems from a growing body of literature demonstrating that 24-hour ambulatory blood pressures (ABPs) are more strongly associated with target organ damage compared with clinic blood pressures (BPs) in patients with chronic kidney disease (CKD).[4–8]

Most guidelines agree that it is normal for clinic BP to be up to 5 mm Hg higher than ABP in the general population, and standard definitions for the diagnosis of white-coat and masked hypertension have been established.[9–12] Many studies have demonstrated a strong association between masked hypertension and risk of adverse cardiovascular and renal outcomes, but white-coat hypertension has not been consistently associated with adverse outcomes.[11,13–17]

Few studies have examined whether the magnitude of the absolute difference between clinic and ABPs among patients with CKD confers important prognostic information. In SPRINT (Systolic Blood Pressure Intervention Trial), large differences between clinic and ABPs were common, especially among patients with CKD randomized to the intensive treatment arm.[18] These differences may be important as we intensify our approach to BP treatment in patients with CKD.[12]

Our objective was to examine whether the difference between clinic and ABP measurements has prognostic implications for risk of death and end-stage renal disease (ESRD) among participants in the AASK (African American Study of Kidney Disease and Hypertension) Cohort Study, one of the largest observational studies of black patients with CKD. We hypothesized that large differences between clinic and ABP (either positive or negative) would be associated with higher risk of adverse outcomes among black patients with CKD.

Methods

AASK Cohort Study

We included participants from AASK Cohort Study, a National Institutes of Health–sponsored observational study that enrolled black patients with CKD who had not yet developed ESRD by the end of the AASK Cohort Study.[19–21] The AASK Cohort Study began in April 2002 and ended in June 2007, and participants had clinic BPs and ABPM performed in close time proximity at study entry.[22–24] At the start of the AASK Cohort Study, all participants were treated to a clinic BP target of <140/90 mm Hg based on results of the AASK Cohort Study;[21,24] the target was changed in 2004 to <130/80 mm Hg because of updated Joint National Committee

guidelines.[23,25] Of AASK Cohort Study participants, 98% (674 of a total 691) had patient identifiers that facilitated ascertainment of ESRD and mortality outcomes. In our current analysis, we additionally excluded 64 participants who did not have ABPM data, deriving a final analytic cohort of 610 participants. Informed consent was obtained at all participating sites for participation in AASK Cohort Study and institutional review board approval for secondary data analysis was obtained at the University of California, San Francisco. Parent AASK Cohort Study data have been made publicly available at the National Institute of Diabetes and Digestive and Kidney Diseases Central Repository.[26]

BP Measurements

Clinic BP

Clinic BPs were obtained by certified personnel using an aneroid device at the time of enrollment into the AASK Cohort Study.[19,22,24] Three consecutive seated readings were obtained at each visit, and the average between the second and third seated readings was considered the clinic BP for the visit. The clinic BP taken from the initial AASK Cohort Study visit that was chronologically closest to ABPM performance was used to calculate the difference between clinic and ABPs. More than 96% of ABPMs were performed within 90 days of clinic BPs (median time difference=8 days).

Ambulatory BP

ABPM was performed at the time of baseline enrollment into the AASK Cohort Study using a SpaceLabs 90207 device, with BPs taken every 30 minutes over a 24-hour period.[5,13] Data from all ABP monitors were sent to the AASK Central Cardiovascular Core Laboratory and read centrally. Awake ABP readings were considered the mean of those BPs that were taken from 6 AM to 12 AM (midnight), as diaries were not available.[5]

Primary Predictor

We computed the difference between clinic BPs and awake ABP readings separately for systolic BP (SBP) and diastolic BP (DBP; henceforth termed clinic-awake difference) as our primary predictor of interest. If clinic BP was higher than awake SBP readings by >5 mm Hg, this was considered a "white-coat" effect (regardless of whether meeting criteria for hypertension). If clinic BP was lower than awake SBP readings, this was considered a "masked" effect (regardless of whether meeting criteria for hypertension). Most AASK cohort participants had a history of diagnosed hypertension and were receiving antihypertensive therapy.[19,21,24] We were most interested in the difference between clinic and awake ABP readings because clinic BPs would be expected to differ more substantially from 24-hour mean ABP because of its

inclusion of nocturnal measurements. However, we also computed the difference between clinic and 24-hour mean ABP readings separately (henceforth termed clinic-ABP difference) as a secondary predictor.

Outcomes

To extend ascertainment of ESRD and vital status beyond the end of the AASK Cohort Study through to June 30, 2012, we performed linkage of AASK Cohort Study participants with the US Renal Data System and the Social Security Death Index.[27,28] All-cause death was our primary outcome given the known benefit of BP control on mortality risk.[29] ESRD was a secondary outcome, as the association between BP lowering and ESRD risk has traditionally been less robust.[21,30]

Statistical Analysis

We used Cox proportional hazards models starting from the date of ABPM to determine the association between clinic-awake (or clinic-ABP) difference with death. We first performed unadjusted Cox models using cubic splines (with 3 evenly spaced knots at −21, 4.5, and 15 mm Hg for clinic-ABP difference). We chose to begin our analysis with cubic splines because these models allowed for greater flexibility in modeling the association between BP and outcomes and can be used to detect nonlinear relationships. Then, we performed additional Cox models after categorizing the clinic-awake and clinic-ABP systolic and diastolic differences as ≥−5 mm Hg (ie, clinic BP is lower than awake or ABP by at least 5 mm Hg), −5 to <0 mm Hg, 0 to <5 mm Hg (reference), 5 to <10 mm Hg, and ≥10 mm Hg. The reference group was selected because of the general acceptance that clinic BPs

can be up to 5 mm Hg higher than awake ABPs and still be considered normal.[20] Although up to a 10−mm Hg difference is the normative difference between clinic and 24-hour mean BPs (because of inclusion of nocturnal readings), we chose to use a 5−mm Hg difference as the reference group for both clinic-awake and clinic-ABP differences because at lower ranges of BPs (eg, SBP <120−130 mm Hg), the normative difference narrows to ≤5 mm Hg.[29] Furthermore, recent data have suggested that black patients have higher nocturnal BPs, and the current normative standards (which were not developed in a racially diverse population) have been questioned.[31]

We examined the association between categories of the clinic-awake or clinic-ABP differences (using separate models for each predictor) with risk of death in unadjusted analyses, followed by a main adjusted model, including age, sex, estimated glomerular filtration rate (eGFR) by the CKD−Epidemiology Collaboration equation,[32] heart disease (defined by a combination of self-report, chart review, or baseline electrocardiogram reading), and proteinuria (measured at cohort entry) in model 1. In model 2, we added clinic SBP as a covariate to model 1. In model 3, we added either mean awake SBP or mean 24-hour ambulatory SBP as a covariate to model 1, depending on whether the primary predictor is clinic-awake SBP or clinic-ambulatory SBP. Finally, because of the strong prognostic significance of sleep BPs in the literature compared with other ABPs,[17] we also added sleep BPs in a sensitivity analysis in model 4. We categorized eGFR by CKD stages (eGFR ≥45, 30−<45, or <30 mL/min per 1.73 m^2) and proteinuria (≥0.5 versus <0.5 g/g or missing) to handle nonnormality in both variables.

We repeated all analyses using DBP differences between clinic and ABPs. We also repeated all analyses using ESRD as our secondary outcome.

Table 1. Characteristics of AASK Cohort Study Participants Included for Analysis by Categories of Difference Between Clinic and Awake SBP

Characteristics	Clinic BP−Mean Awake ABP, mm Hg				
	White-Coat Effect		Reference	Masked Effect	
	≥10	5 to <10	0 to <5	−5 to <0	≥−5
	(N=93)	(N=56)	(N=70)	(N=97)	(N=294)
Age, y	60.4±9.3	61.2±8.4	59.5±10.9	58.5±9.7	60.1±10.6
Female sex	43 (46.2)	33 (58.9)	29 (41.4)	36 (37.1)	92 (31.3)
Heart disease	35 (35)	34 (61)	56 (58)	65 (70)	197 (67)
eGFR, mL/min per 1.73 m^2	39.9±16.5	36.3±15.0	35.9±15.2	42.7±16.3	39.2±15.2
Proteinuria, median (IQR), g/g*	0.05 (0.02–0.1)	0.09 (0.04–0.34)	0.07 (0.03–0.26)	0.05 (0.03–0.29)	0.06 (0.03–0.32)
Randomized to strict BP control during the AASK Cohort Study	49 (52.7)	30 (53.6)	30 (42.9)	48 (49.5)	147 (50.0)

Data are given as mean±SD or number (percentage), unless otherwise indicated. AASK indicates African American Study of Kidney Disease and Hypertension; ABP, ambulatory BP; BP, blood pressure; eGFR, estimated glomerular filtration rate; IQR, interquartile range; SBP, systolic BP.
*Missing in N=81.

Table 2. Mean BP Among Each of the Categories of the Difference Between Clinic and Awake SBP

BP Variable	Clinic BP–Mean Awake ABP, mm Hg									
	White-Coat Effect				Reference		Masked Effect			
	≥10 (N=93)		5 to <10 (N=56)		0 to <5 (N=70)		−5 to <0 (N=97)		≥−5 (N=294)	
	SBP	DBP	SBP	DBP	SBP	DBP	SBP	DBP	SBP	DBP
Mean clinic BP at visit closest to ABPM performance, mm Hg	152.0±21.8	92.1±12.9	143.2±17.4	86.6±9.6	140.0±16.3	83.3±9.8	131.4±15.9	77.8±8.9	125.4±16.2	74.3±10.8
Mean 24-h ABPM, mm Hg	131.2±17.0	77.9±11.0	134.7±17.7	77.5±11.2	136.7±16.6	81.7±10.2	133.0±15.6	80.8±10.1	140.2±16.8	82.7±10.2
Mean awake ABPM, mm Hg	132.1±16.9	79.3±11.2	135.9±17.6	79.1±11.4	137.6±16.2	83.0±10.4	134.0±15.7	82.2±10.2	140.9±16.6	83.9±10.1

ABP indicates ambulatory BP; ABPM, ABP monitoring; BP, blood pressure; DBP, diastolic BP; SBP, systolic BP.

Finally, we tested for prespecified interactions by adding interaction terms between the clinic-awake SBP difference or clinic-ABPM SBP difference with the following: (1) baseline clinic SBP; and separately (2) mean awake SBP (when clinic-awake SBP difference is the primary predictor) or mean 24-hour ambulatory SBP (when clinic-ABPM SBP difference is the primary predictor). These analyses were designed to determine whether the magnitude of the clinic-awake or clinic-ABP differences and their associations with death differed depending on the level of achieved SBP.

STATA 14 was used for statistical analyses. For all analyses, $P < 0.05$ was considered statistically significant.

Results

Characteristics of the 610 AASK Cohort Study participants are shown in Tables 1 and 2. Overall mean age was 60.5 years, 38% of the cohort were women, and mean eGFR was 39 mL/min per 1.73 m^2. Mean clinic SBP was 134±20 mm Hg, and mean clinic DBP was 80±12 mm Hg, at cohort entry. In general, more women had white-coat effect and fewer women had masked effect, but there were no differences in age, prior BP target randomization arm, baseline eGFR, or proteinuria between different categories of the clinic-awake difference (Table 1). Heart disease was more prevalent among those with masked effect compared with those with white-coat effect. The distribution of the clinic, 24-hour ABP, and ABP awake BPs is shown in Table 2. Approximately 24% of patients had white-coat effect and 64% had masked effect using the difference between clinic and awake SBP.

Risk of All-Cause Mortality

During a median follow-up of 9.9 years, 200 (of 610) participants died. A U-shaped association was found between the magnitude of the clinic-awake SBP difference (either positive or negative) and the risk of death (Figure—Panel A). Results of the association when the magnitude of the clinic-awake difference was examined categorically are shown in Table 3. Compared with the reference group (clinic-awake SBP difference of 0–<5 mm Hg), participants with a clinic SBP that was 5 to <10 mm Hg higher than awake SBP had at least a 1.84 times greater risk of death (model 1), although this finding did not achieve statistical significance. Those with a >10–mm Hg higher clinic SBP than awake SBP had a 2.31 times higher risk of death (Table 3). There was no difference in the risk of death among study participants with a clinic-awake SBP difference of −5 to 0 mm Hg compared with the reference group in model 1 (hazard ratio, 1.15 [95% CI, 0.59–2.24]). However, if the clinic-awake SBP difference was ≥−5 mm Hg, the adjusted risk of death was statistically significantly higher than that for the reference group (hazard
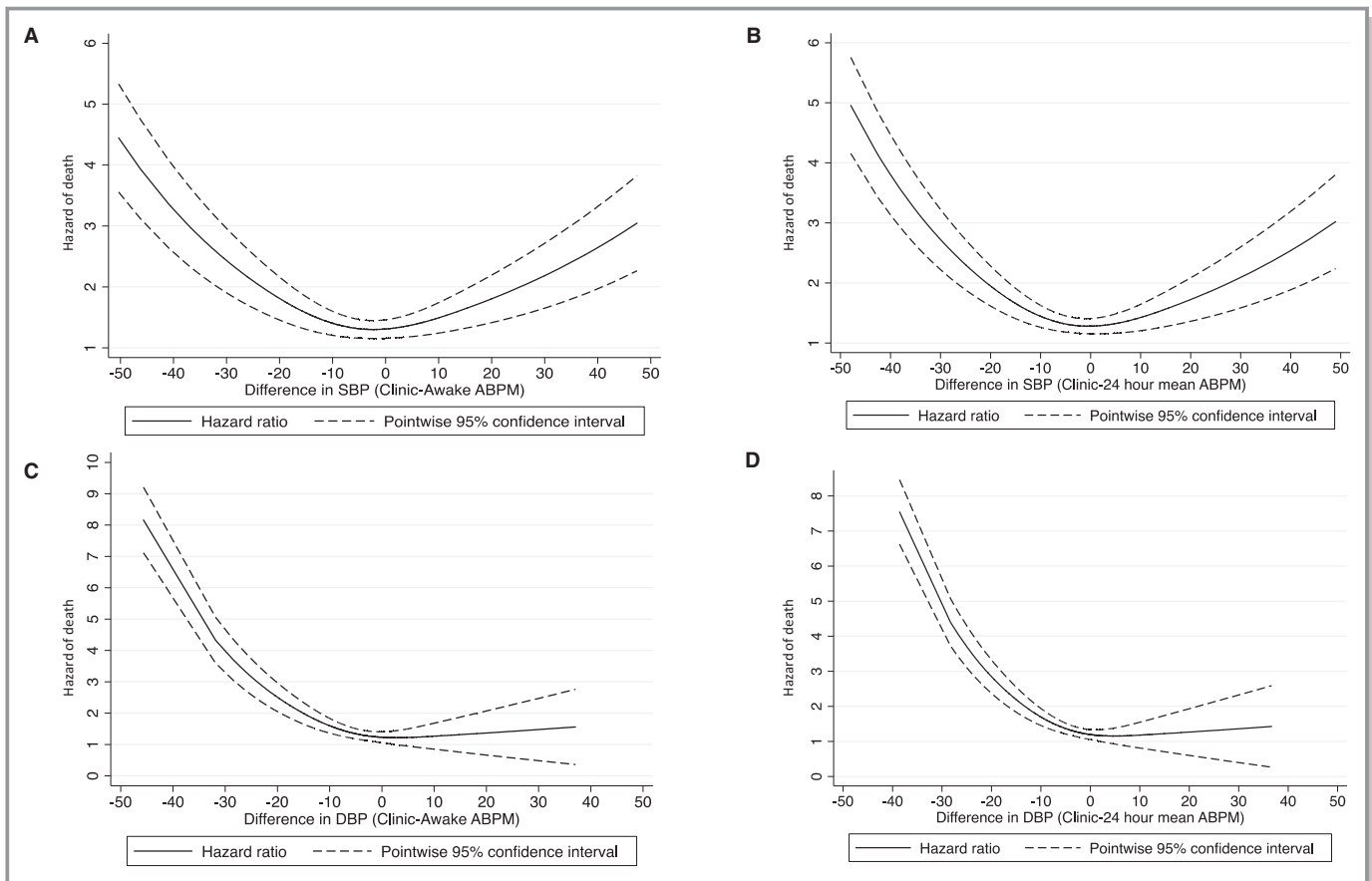
Figure. Association between clinic-awake or clinic–ambulatory blood pressure (ABP) and risk of death in unadjusted models. Risk of death based on difference between clinic and ABP monitoring (ABPM) systolic blood pressure (SBP; 24 hour and awake). **A**, U-shaped association between the magnitude of the clinic-awake ABPM SBP difference and the risk of death. **B**, U-shaped association between the magnitude of the clinic–24-hour mean ABPM SBP difference and the risk of death. **C** and **D**, Clinic-ABPM diastolic blood pressure (DBP) not associated with risk of death.

ratio, 1.82 [95% CI, 1.05–3.15]). Additional adjustment accounting for demographics, kidney function, heart disease, proteinuria, as well as clinic, awake, or sleep SBP did not substantially alter findings (models 2–4, Table 3).

Similar results were found when examining the association between clinic–systolic ABP difference and the risk of death. We found a U-shaped association between the magnitude of the clinic–ambulatory SBP difference (either positive or negative) and the risk of death (Figure––Panel B). A higher risk of death was also noted among individuals with categories of clinic-ambulatory SBP difference of >5 mm Hg or ≥−5 mm Hg in unadjusted analysis (Table 4); with further adjustment in model 1, a ≥10– or ≥−5–mm Hg difference in clinic ambulatory SBP was statistically significantly associated with risk of death (Table 4). Additional adjustments for clinic SBP, 24-hour mean, or sleep SBP did not substantially alter findings (models 2–4).

We tested for but did not find significant interactions between categories of the clinic-awake or clinic-ABP difference with baseline clinic SBP, mean awake SBP, or 24-hour SBP (all *P*>0.05).

The relationship between DBP and outcomes of interest differed from that observed for SBP. Specifically, presence of clinic DBP higher than ambulatory DBP (either awake or mean 24-hour DBP in a white-coat effect) was not associated with risk of death in our spline-based analyses (Figure–Panels C and D). However, clinic DBP lower than ambulatory DBP (masked effect) appeared to have a continuous and graded association with mortality risk that was similar to that observed for SBP. When the clinic-awake or clinic-ABPM DBP differences were categorized, a difference ≥−5 mm Hg was statistically significantly associated with mortality risk in adjusted analyses (data not shown).

Risk of ESRD

A total of 178 participants developed ESRD during follow-up. The continuous relationship between the magnitude of the clinic-awake and clinic-ABP difference with risk of ESRD is shown in Figure S1A and S1B for SBPs and Figure S1C and S1D for DBPs. There was no statistically significant association between the magnitude of the clinic-awake or clinic–ABP

Table 3. Difference Between Clinic and Mean Awake ABP and Long-Term Risk of Death

Systolic BP, mm Hg			Fully Adjusted Models, Hazard Ratio (95% CI)			
(Clinic−Awake Ambulatory BP)	N	Unadjusted	Model 1	Model 2	Model 3	Model 4
"White-coat effect"						
≥10	93	2.30 (1.27–4.18)	2.31 (1.27–4.22)	2.10 (1.14–3.86)	2.62 (1.43–4.81)	2.53 (1.38–4.62)
5 to <10	56	2.07 (1.07–4.02)	1.84 (0.94–3.56)	1.85 (0.95–3.61)	1.98 (1.01–3.87)	1.96 (1.01–3.84)
0 to <5	70	Reference	Reference	Reference	Reference	Reference
"Masked effect"						
−5 to <0	97	1.04 (0.54–2.02)	1.15 (0.59–2.24)	1.25 (0.64–2.43)	1.22 (0.62–2.37)	1.21 (0.62–2.36)
≥−5	294	1.82 (1.06–3.13)	1.82 (1.05–3.15)	2.14 (1.22–3.75)	1.79 (1.03–3.09)	1.76 (1.02–3.05)

Model 1: All fully adjusted models are adjusted for age, sex, heart disease, estimated glomerular filtration rate at cohort entry, and proteinuria. Model 2: Adjusted model+clinic systolic BP. Model 3: Adjusted model+either mean awake ambulatory systolic BP (Table 3) or mean 24-hour ambulatory systolic BP (Table 4), depending on whether the difference is between clinic-awake systolic BP or clinic−ABP monitoring systolic BP. Model 4: Adjusted model+mean 24-hour asleep systolic BP. ABP indicates ambulatory BP; BP, blood pressure.

systolic or diastolic difference and risk of ESRD in unadjusted analyses (Tables S1 and S2). In adjusted analyses, extremes of differences (>10 or ≥−5 mm Hg) in clinic-awake or clinic-ambulatory DBP were associated with a higher risk of ESRD in adjusted analyses, and further adjustment for ABPM parameters did not substantially alter results (data not shown).

Discussion

In the population with CKD, ≈10% to 30% of patients are reported to have white-coat hypertension, and ≈30% to 60% of patients with CKD have masked hypertension.[4,8,13,33,34] However, neither masked nor white-coat hypertension can be detected without out-of-office BP measurements, and 24-hour ABPM remains the preferred standard measure of out-of-office BPs.[10,35] Although many observational studies have demonstrated the prognostic significance of ABPM parameters that support the routine ascertainment of ABPs, most of these studies have either examined the prognostic significance of individual parameters (eg, nocturnal SBP) as continuous variables or categorized clinic BPs as white-coat, masked, or confirmed hypertension for study.[5,7,8,13,36]

In this study, we found that, compared with a clinic-awake or clinic-ABP difference of 0 to <5 mm Hg (considered a normal difference), there was a continuous, U-shaped relationship between positive or negative absolute differences in clinic-awake or clinic-ABP SBP measurements with mortality risk. Specifically, when a white-coat effect was present (clinic SBP higher than ambulatory SBP by ≥5 mm Hg), the clinic-awake and clinic-ABP differences were strongly associated with mortality risk in a graded manner. When a masked effect was present (clinic SBP lower than ambulatory SBP), the clinic-awake and clinic-ABP differences were only associated with mortality risk if this absolute difference was ≥5 mm Hg. These findings were not attenuated after adjustment for clinic SBP, ambulatory SBP, sleep SBP, or proteinuria, suggesting that the absolute difference between clinic and ABP provides independent prognostic information beyond achieved SBP. The magnitude of the clinic-awake or clinic-ABPM SBP difference was not associated with risk of ESRD.

Table 4. Difference Between Clinic and Mean 24-Hour ABP and Long-Term Risk of Death

Systolic BP, mm Hg			Fully Adjusted Models, Hazard Ratio (95% CI)			
(Clinic−Ambulatory BP)	N	Unadjusted	Model 1	Model 2	Model 3	Model 4
≥10	104	2.34 (1.29–4.22)	2.18 (1.20–3.95)	1.95 (1.07–3.56)	2.47 (1.35–4.49)	2.36 (1.30–4.28)
5 to <10	58	1.99 (1.02–3.89)	1.59 (0.81–3.13)	1.59 (0.81–3.13)	1.72 (0.87–3.38)	1.71 (0.87–3.37)
0 to <5	77	Reference	Reference	Reference	Reference	Reference
−5 to <0	91	1.31 (0.68–2.53)	1.38 (0.72–2.67)	1.50 (0.78–2.91)	1.45 (0.75–2.81)	1.34 (0.70–2.60)
≥−5	280	2.07 (1.20–3.56)	1.85 (1.07–3.21)	2.20 (1.25–3.87)	1.80 (1.04–3.11)	1.69 (0.97–2.93)

Model 1: All fully adjusted models are adjusted for age, sex, heart disease, estimated glomerular filtration rate at cohort entry, and proteinuria. Model 2: Adjusted model+clinic systolic BP. Model 3: Adjusted model+either mean awake ambulatory systolic BP (Table 3) or mean 24-hour ambulatory systolic BP (Table 4), depending on whether the difference is between clinic-awake systolic BP or clinic−ABP monitoring systolic BP. Model 4: Adjusted model+mean 24-hour asleep systolic BP. ABP indicates ambulatory BP; BP, blood pressure.

A few prior studies have examined the implications of the magnitude of the difference between clinic and ABP measurements in the context of variations in the response of this difference to antihypertensive therapy, and changes to these differences have been observed as aging occurs in populations without CKD.[36–38] Our study results extend those from prior observations to examine the association of those differences with mortality and ESRD, arguably outcomes of greatest interest to patients. Consistent with prior studies that have shown that masked hypertension is associated with risk of adverse outcomes,[39,40] we found that masked clinic-awake or clinic-ABPM SBP differences of ≥5 mm Hg were associated with a higher risk of death, regardless of whether absolute SBP met the definition for hypertension. It is possible that these findings may be driven by the well-performed protocol-driven AASK clinic BP readings, which have important prognostic value and are likely lower than non–protocol-driven clinic BP readings.

We also found that clinic SBP readings that represented a white-coat effect were strongly associated with the risk of death. A few studies of patients in the *general population* have suggested that presence of white-coat hypertension is associated with higher-risk cardiovascular outcomes and may be a precursor to the development of sustained hypertension.[40–45] Our findings are consistent with recent studies that also demonstrated that white-coat hypertension was not benign and was associated with cardiovascular risk during long-term follow-up.[17,46] Prior studies have noted that the prevalence of white-coat hypertension is more common among women in the general population,[47,48] whereas masked hypertension may be more common in men.[49] Our findings are consistent with those of the literature in the general population, and in the setting of a new diagnosis of hypertension, confirmation of the diagnosis using ABPM, especially in black women, could help prevent overtreatment.

Having a large difference between clinic and ABPs may also reflect heightened variability or "volatility" of BP measurements or increased levels of sympathetic overactivity, which may be associated with long-term cardiovascular risk. However, it is also possible that these findings are specific to the black population with CKD, as little is known about racial differences in the prognostic value of ABP in the population with CKD. On the basis of our findings, a clinic-ABP difference of >5 mm Hg, suggestive of white-coat phenomena, should not be completely ignored as benign among black patients with CKD. Thus, we believe that even in the presence of white-coat hypertension, patients with CKD who exhibit a large difference between clinic and ABPs may need closer follow-up and intensive cardiovascular risk reduction, as these patients are at elevated risk for death during long-term follow-up. In contrast, those patients with smaller magnitudes of difference (eg, <5 mm Hg) between ambulatory and clinic BPs may be at lower risk for adverse cardiovascular events.

We did not find the difference between clinic-ABP or clinic-awake SBP or DBP to be consistently associated with the risk of ESRD. Prior studies of patients with CKD have also not found ABP measurements to be consistently associated with renal outcomes, especially after accounting for other risk factors for CKD progression.[7] Our results are overall consistent with the null effects of several adult BP-lowering trials on ESRD outcomes.[21,23,29,30]

The strengths of this study include the use of a well-characterized cohort and availability of well-performed research-grade clinic BPs and ABPs. Limitations include the focus on a black population with hypertension-attributed CKD, so our results may not generalize to all patients with CKD. Also, the number of participants with white-coat effect was smaller, and this warrants replication with a larger sample size with a higher number of events. The AASK Cohort Study was also unique in the long-term relationship between participants and study coordinators who obtained BP readings, which may have reduced white-coat effects during clinic measurements.[50] We also do not have causes of death and, therefore, are unable to examine the risk of cardiovascular-related mortality. Finally, although repeated ABPMs were performed every 2 years during the duration of the AASK Cohort Study, the number of participants with ABPM declined precipitously after the baseline ABPM; and those who died would not have had a subsequent ABPM (which may lead to survivor bias), so we have chosen not to include analysis of subsequent ABPs in this study.

In conclusion, the magnitude of the difference between clinic and ambulatory SBP measurements has prognostic significance and should be considered during BP assessments among patients with CKD. Our results suggest that the presence of a white-coat effect may be associated with higher risk of death, even when clinic or ambulatory SBPs are controlled. We believe that it is important to invest in more widespread implementation of ABPM and efforts to obtain consistent, high-quality, clinic BP measurements to accurately collect data that may inform antihypertensive therapy in patients with CKD. Further studies are needed to confirm these findings in more racially diverse populations and to examine whether therapeutic changes to alter clinic-ABP differences may lead to improved outcomes.

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Disclosures

None.

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SUPPLEMENTAL MATERIAL

Table S1. Difference between clinic and mean awake ambulatory blood pressure and risk of ESRD.

N=610		Systolic BP			Diastolic BP	
Difference taking clinic –ambulatory	N	Unadjusted Hazard Ratio (95% CI)	Adjusted* Hazard Ratio (95% CI)		Unadjusted Hazard Ratio (95% CI)	Adjusted* Hazard Ratio (95% CI)
≥10 mm Hg	93	0.83 (0.49-1.43)	1.56 (0.88-2.76)	73	1.11 (0.61-2.02)	1.80 (0.96-3.35)
5 to <10 mm Hg	56	0.82 (0.44-1.53)	1.06 (0.55-2.03)	73	1.57 (0.93-2.66)	2.01 (1.18-3.43)
0 to <5 mm Hg	97	Ref	Ref	124	Ref	Ref
-5 to <0 mm Hg	70	0.67 (0.39-1.16)	1.26 (0.72-2.20)	126	1.18 (0.74-1.87)	1.47 (0.92-2.34)
≥ -5 mm Hg	294	0.78 (0.50-1.20)	1.29 (0.81-2.05)	214	1.01 (0.67-1.54)	1.60 (1.03-2.48)

*Adjusted for age, sex, heart disease, eGFR at cohort entry, and proteinuria
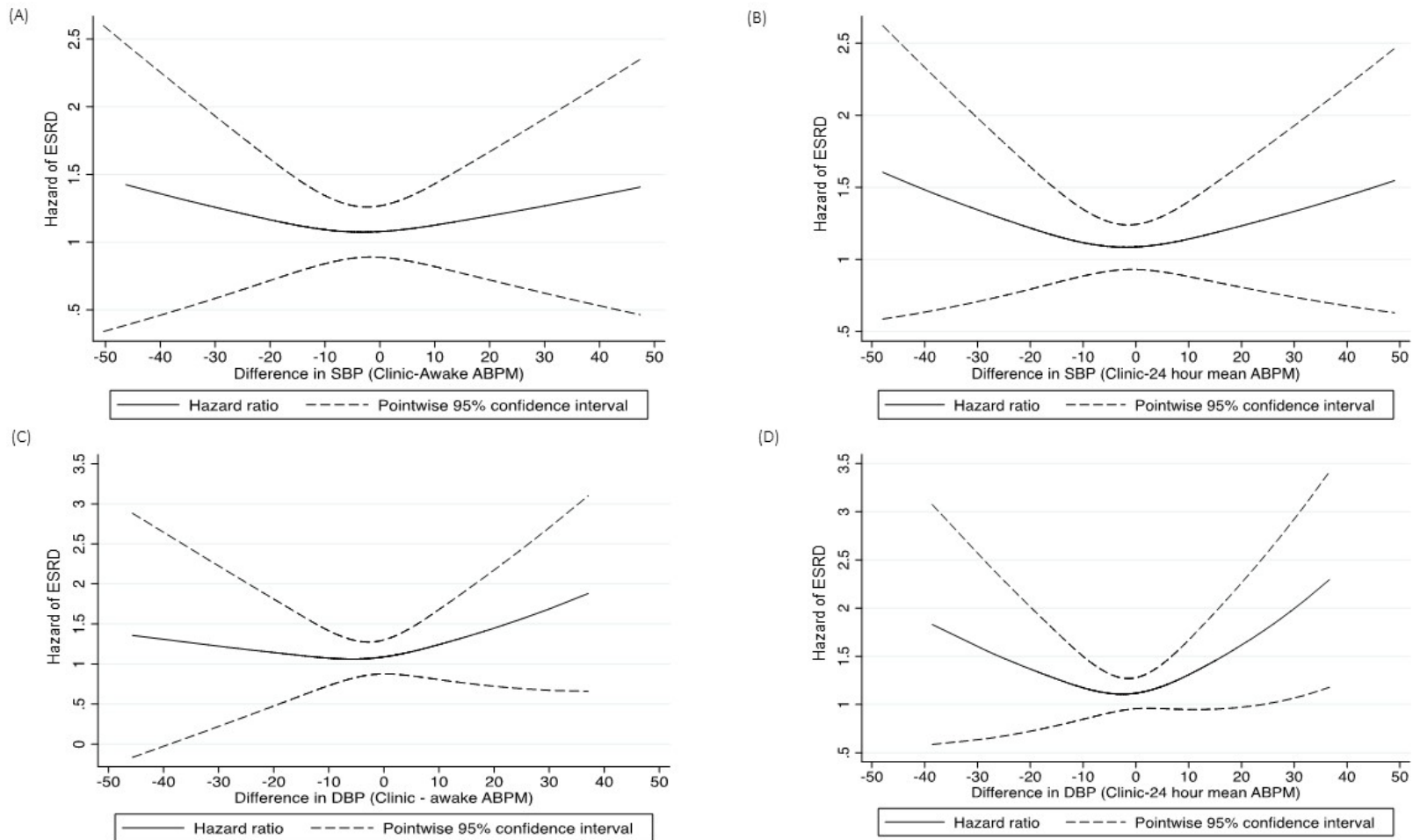ESRD=end-stage renal disease

Table S2. Difference between clinic and mean ambulatory blood pressure and risk of ESRD.

N=610		Systolic BP			Diastolic BP	
Difference taking clinic –ABPM	N	Unadjusted Hazard Ratio (95% CI)	Adjusted* Hazard Ratio (95% CI)	N	Unadjusted Hazard Ratio (95% CI)	Adjusted* Hazard Ratio (95% CI)
≥10 mm Hg	104	1.16 (0.67-2.01)	1.80 (1.01-3.21)	54	1.70 (1.01-2.87)	1.70 (1.00-2.88)
5 to <10 mm Hg	58	1.36 (0.73-2.51)	1.63 (0.87-3.06)	64	1.18 (0.67-2.06)	1.23 (0.69-2.17)
0 to <5 mm Hg	77	Ref	Ref	119	Ref	Ref
-5 to <0 mm Hg	91	0.94 (0.52-1.68)	1.38 (0.76-2.51)	122	1.36 (0.85-2.17)	1.38 (0.86-2.21)

| ≥ -5 mm Hg | 280 | 1.19 (0.74-1.90) | 1.73 (1.07-2.82) | 251 | 1.28 (0.82-1.98) | 1.71 (1.10-2.68) |

*Adjusted for age, sex, heart disease, eGFR at cohort entry, and proteinuria
ESRD= end-stage renal disease

Figure S1. **Risk of ESRD based on difference between office and ABPM systolic and diastolic (24 hour and awake).**

ESRD=end-stage renal disease, ABPM=ambulatory blood pressure monitoring, SBP=systolic blood pressure, DBP=diastolic blood pressure