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SHORT REPORT

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The impact of changing home blood pressure monitoring cutoff from 135/85 to 130/80 mmHg on hypertension phenotypes

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Abstract

This study investigated the impact of changing abnormal home blood pressure monitoring (HBPM) cutoff from 135/85 to 130/80 mmHg on the prevalence of hypertension phenotypes, considering an abnormal office blood pressure cutoff of 140/90 mmHg. We evaluated 57 768 individuals (26 876 untreated and 30 892 treated with antihypertensive medications) from 719 Brazilian centers who performed HBPM. Changing the HBPM cutoff was associated with increases in masked (from 10% to 22%) and sustained (from 27% to 35%) hypertension, and decreases in white-coat hypertension (from 16% to 7%) and normotension (from 47% to 36%) among untreated participants, and increases in masked (from 11% to 22%) and sustained (from 29% to 36%) uncontrolled hypertension, and decreases in white-coat uncontrolled hypertension (from 15% to 8%) and controlled hypertension (from 45% to 34%) among treated participants. In conclusion, adoption of an abnormal HBPM cutoff of 130/80 mmHg markedly increased the prevalence of out-of-office hypertension and uncontrolled hypertension phenotypes.

1 | BACKGROUND

Measurements of out-of-office blood pressure (BP), including home BP monitoring (HBPM) and ambulatory BP monitoring, have been recommended to confirm and manage hypertension.[1–4] Several guidelines have suggested that office BP values ≥140/90 mmHg and HBPM values ≥135/85 mmHg should be used to define hypertension.[1,4] These HBPM thresholds were mainly derived from reports published in late 1990s, which built cutoffs based on HBPM ninety-fifth percentiles values of selected populations[5] and HBPM values associated with early mortality risk among participants of the Ohasama Study.[6] However, numerous studies published in the last decade challenged this notion and indicated that HBPM levels lower than 135/85 mmHg are more suitable to detected elevated BP at home.[7–11] For instance, regression analysis of a large multicenter sample showed that HBPM values of 130/82 mmHg corresponded to office BP values of 140/90 mmHg,[8] while a meta-analysis of five studies found that HBPM values of 131.9/82.4 mmHg corresponded to office BP values of 140/90 mmHg in predicting cardiovascular events.[9] In addition, HBPM values <130/80 mmHg were associated with lower risk of end-organ damage than HBPM values <135/85 mmHg,[10] whereas HBPM values ≥130/80 mmHg had superior accuracy to detect hypertension using ambulatory BP monitoring measurements as reference than HBPM values ≥135/85 mmHg.[11] As a result, some recent hypertension guidelines have suggested that abnormal HBPM levels should be considered when ≥130/80 mmHg rather than ≥135/85 mmHg, albeit keeping abnormal office BP values ≥140/90 mmHg.[3] This study evaluated the impact of changing abnormal HBPM cutoff from 135/85 to 130/80 mmHg on the prevalence of hypertension phenotypes in a large Brazilian multicenter sample, considering a fixed cutoff of 140/90 mmHg for abnormal office BP.

2 | METHODS

This cross-sectional study evaluated 57 768 unique individuals (26 876 untreated and 30 892 treated with antihypertensive medications) with age ≥18 years from 719 Brazilian centers who performed HBPM from May 2017 to December 2020 using an online platform (www.telemrpa.com).[8,12,13] The protocol was approved by the Ethics Committee of the Oswaldo Cruz University Hospital/PROCAPE Complex, which waived the requirement for informed consent, and is in accordance with the ethical guidelines of the 1975 Declaration of Helsinki.

Information on sex, age, and body mass index was gathered from all participants. Office and home BP were measured with the participant in the sitting position using appropriate cuff size and validated upper arm cuff devices (HEM 705 CP, HEM 7113, HEM 7320, or HEM 9200T; Omron Healthcare, Japan), as previously reported.[8,12,13] Briefly, office BP values comprised the average of two BP readings attended by health staff after at least 3 min of rest, while HBPM values were calculated as the average of all home BP measurements (23.4 ± 1.8 readings) comprising three home BP measurements in the morning and in the evening after at least 3 min of rest for four consecutive days, before antihypertensive medications were taken.

Normal office or home BP values were considered when both respective systolic and diastolic BP measures were lower that the studied BP cutoffs (140/90 mmHg for office BP,[1,3,4] and 130/80 mmHg[3] or 135/85 mmHg[1,4] for home BP), and elevated office or home BP values were considered when either respective systolic or diastolic BP measures were equal or greater than the studied BP cutoffs. Among untreated participants, BP phenotypes were defined as follows: normotension (normal office and home BP), white-coat hypertension (elevated office BP and normal home BP), masked hypertension (normal office BP and elevated home BP), and sustained hypertension (elevated office and home BP). The corresponding terms among treated individuals were controlled hypertension, white-coat uncontrolled hypertension, masked uncontrolled hypertension, and sustained uncontrolled hypertension, respectively.[1,3]

Continuous and categorical variables are presented as mean ± standard deviation and proportion. Comparisons of variables among the studied groups within untreated or treated individuals were performed using chi-square test for categorical variables and one-way ANOVA followed by Bonferroni's test for continuous variables. p-values <.05 were considered significant. Statistical analysis was performed using Stata software version 14.1 (Stata Corp LP).

3 | RESULTS

Untreated participants (n = 26 876) were 41% males and had age = 53 ± 16 years, body mass index = 28.4 ± 5.3 kg/m^2, office systolic BP = 130 ± 19 mmHg and diastolic BP = 85 ± 12 mmHg, and home systolic BP = 124 ± 15 mmHg and DBP = 80 ± 9 mmHg, while treated participants (n = 30 892) were 37% males, had age = 60 ± 15 years, body mass index = 28.9 ± 5.2 kg/m^2, office systolic BP = 134 ± 21 mmHg and diastolic BP = 84 ± 12 mmHg, and home systolic BP = 127 ± 16 mmHg and DBP = 79 ± 10 mmHg.

Changing the HBPM cutoff from 135/85 to 130/80 mmHg was associated with significant (p < .001) increases in masked hypertension (from 10% to 22%) and sustained hypertension (from 27% to 35%), and decreases in white-coat hypertension (from 16% to 7%) and normotension (from 47% to 36%) among untreated participants, as well as increases in masked uncontrolled hypertension (from 11% to 22%) and sustained uncontrolled hypertension (from 29% to 36%), and decreases in white-coat uncontrolled hypertension (from 15% to 8%) and controlled hypertension (from 45% to 34%) among treated participants (Figure 1). Furthermore, there was a marked increase in the summed prevalence of masked and sustained hypertension (from 37% to 57%; p < .001) and in the summed prevalence of masked and sustained uncontrolled hypertension (from 40% to 58%; p < .001), when shifting the HBPM cutoff from 135/85 to 130/80 mmHg.

The clinical and BP characteristics of the participants according to BP phenotypes derived from the HBPM cutoffs of 135/85 and

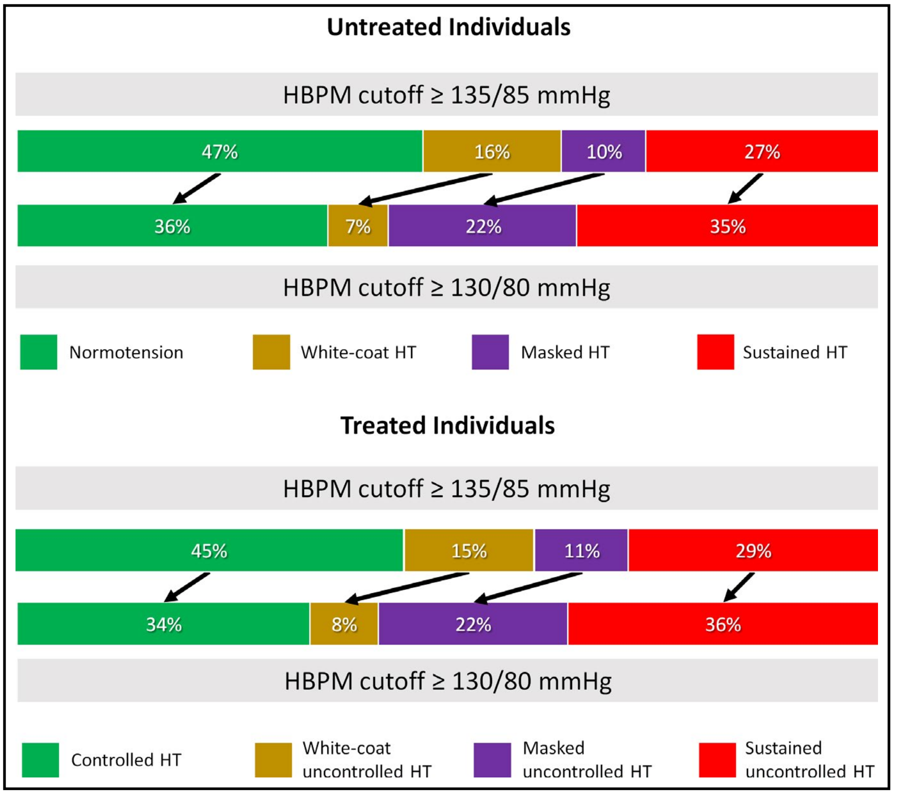

FIGURE 1 Hypertension phenotypes in participants untreated or treated with antihypertensive medications considering abnormal HBPM cutoffs of 135/85 or 130/80 mmHg. All analyses considered an abnormal office blood pressure cutoff of 140/90 mmHg. HBPM, home blood pressure monitoring; HT, hypertension

130/80 mmHg are shown in Table 1. When assuming the HBPM cutoff of 130/80 mmHg, participants with white-coat hypertension and white-coat uncontrolled hypertension had the highest age among BP phenotypes regarding the untreated and treated samples, respectively. Conversely, the prevalence of men and average body mass index tended to be greater among untreated participants with sustained and masked hypertension and treated participants with sustained and masked uncontrolled hypertension, regardless of the used HBPM cutoff.

4 | DISCUSSION

The present report evaluated a large real-world sample of treated and untreated individuals and found that shifting the HBPM abnormal cutoff from 135/85 to 130/80 mmHg and keeping the office abnormal cutoff at 140/90 mmHg led to a twofold increase in the prevalence of masked hypertension phenotypes, an approximate 50% decrease in the prevalence of white-coat hypertension phenotypes, and increased the detection of sustained hypertension phenotypes and decreased the detection of normotension and controlled hypertension. We also observed an approximate 50% increase in the summed prevalence of hypertension phenotypes derived from elevated HBPM values when shifting the HBPM cutoff from 135/85 to 130/80 mmHg. Given the superior prognostic value of HBPM measurements in comparison with office BP measurements,[1,2,3,4] the present findings support the necessity of regular measurement of out-of-office BP to identify and manage hypertension when using an abnormal HBPM cutoff of 130/80 mmHg. Furthermore, the remarkably elevated prevalence of masked phenotypes associated with the adoption of HBPM cutoff of 130/80 mmHg might provide a potential explanation for the residual cardiovascular risk reported for patients with office BP levels lower than 140/90 mmHg.[2] Conversely, it is worth mentioning that decreasing the abnormal HBPM cutoff to 130/80 mmHg may also increase the use of antihypertensive drugs and related costs. Further studies evaluating long-term outcomes are necessary to confirm whether adopting a lower HBPM cutoff has favorable cost-effectiveness.

The HBPM cutoff of 130/80 mmHg has been previously proposed by the 2017 American College of Cardiology/American Heart Association (2017-ACC/AHA) hypertension guidelines.[2] However, the 2017-ACC/AHA guidelines also suggested an office BP cutoff of 130/80 mmHg, which markedly differs from the office cutoff used in the current analysis (140/90 mmHg). Therefore, the impact of our studied BP cutoffs and those proposed by the 2017-ACC/AHA guidelines are not interchangeable. Indeed, former studies showed that the substitution of "traditional" BP cutoffs (i.e., 140/90 mmHg for office and 135/85 mmHg for home BP) for those proposed by the 2017-ACC/AHA BP guidelines was associated with increases in the prevalence of white-coat hypertension phenotypes and decreases in masked hypertension phenotypes,[14,15] which were contrary to our current findings.

This study has some limitations. First, data regarding alternative cardiovascular risk factors, including diabetes, smoking, and dyslipidemia, were not available. Second, the lack of information on adverse outcomes at follow-up limits our ability to evaluate the prognostic value of the hypertension phenotypes. Third, it is possible that

TABLE 1 Characteristics of the participants according to hypertension phenotypes defined by the studied abnormal HBPM cutoffs

Abnormal HBPM cutoff	135/85 mmHg				130/80 mmHg			
Untreated participants								
Phenotypes	NT	WH	MH	SH	NT	WH	MH	SH
N	12 775	4,242	2,664	7,195	9,530	1,991	5,909	9,446
Men, %	38	41[a]	43[a]	45[a,b]	37	38	43[a,b]	45[a,b]
Age, years	51 ± 16	54 ± 16[a]	55 ± 16[a]	55 ± 16[a]	51 ± 16	56 ± 16[a]	53 ± 16[a,b]	54 ± 16[a,b,c]
Body mass index, kg/m^2	28.0 ± 5.1	28.4 ± 5.4[a]	28.8 ± 5.4[a,b]	28.9 ± 5.5[a,b]	27.8 ± 5.0	28.1 ± 5.4	28.8 ± 5.2[a,b]	28.8 ± 5.4[a,b]
Office systolic BP, mmHg	118 ± 12	141 ± 14[a]	125 ± 10[a,b]	148 ± 18[a,b,c]	117 ± 12	142 ± 14[a]	123 ± 10[a,b]	146 ± 17[a,b,c]
Office diastolic BP, mmHg	77 ± 8	91 ± 8[a]	81 ± 7[a,b]	96 ± 11[a,b,c]	76 ± 8	89 ± 8[a]	81 ± 6[a,b]	95 ± 10[a,b,c]
Home systolic BP, mmHg	115 ± 10	121 ± 8[a]	132 ± 11[a,b]	139 ± 14[a,b,c]	112 ± 9	118 ± 8[a]	127 ± 10[a,b]	135 ± 14[a,b,c]
Home diastolic BP, mmHg	74 ± 6	77 ± 6[a]	86 ± 6[a,b]	89 ± 9[a,b,c]	72 ± 5	74 ± 5[a]	83 ± 6[a,b]	87 ± 9[a,b,c]
Treated participants								
Phenotypes	CH	WUCH	MUCH	SUCH	CH	WUCH	MUCH	SUCH
N	13 816	4,837	3,365	8,874	10 362	2,548	6,819	11 163
Men, *n* (%)	34	36[a]	40[a,b]	40[a,b]	33	31	39[a,b]	40[a,b]
Age, years	59 ± 14	61 ± 15[a]	61 ± 15[a]	62 ± 15[b]	60 ± 14	62 ± 14[a]	59 ± 15[b]	61 ± 15[a,b,c]
Body mass index, kg/m^2	28.9 ± 5.2	28.6 ± 5[a]	28.9 ± 5	29.1 ± 5[b]	28.8 ± 5.2	28.2 ± 5.1[a]	29.2 ± 5[a,b]	29.1 ± 5.4[a,b]
Office systolic BP, mmHg	119 ± 12	144 ± 14[a]	125 ± 10[a,b]	153 ± 19[a,b,c]	118 ± 12	145 ± 13[a]	123 ± 10[a,b]	151 ± 19[a,b,c]
Office diastolic BP, mmHg	76 ± 8	89 ± 9[a]	79 ± 8[a,b]	94 ± 12[a,b,c]	75 ± 8	87 ± 9[a]	80 ± 7[a,b]	93 ± 11[a,b,c]
Home systolic BP, mmHg	116 ± 10	122 ± 8[a]	135 ± 11[a,b]	143 ± 15[a,b,c]	114 ± 9	119 ± 8[a]	129 ± 11[a,b]	139 ± 16[a,b,c]
Home diastolic BP, mmHg	73.5 ± 7	76 ± 6[a]	84 ± 7[a,b]	87 ± 10[a,b,c]	71 ± 6	72 ± 6[a]	82 ± 6[a,b]	86 ± 10[a,b,c]

Note: The cutoff used to define abnormal office BP was 140/90 mmHg.

Abbreviations: BP, blood pressure; CH, controlled hypertension; HBPM, home blood pressure monitoring; MH, masked hypertension; MUCH, masked uncontrolled hypertension; NT, normotension; SH, sustained hypertension; SUCH, sustained uncontrolled hypertension; WH, white-coat hypertension; WUCH, white-coat uncontrolled hypertension.

[a] $p < .05$ compared with participants with NT (among untreated participants) or CH (among treated participants) considering the same HBPM cutoff.

[b] $p < .05$ compared with participants with WH (among untreated participants) or WUCH (among treated participants) considering the same HBPM cutoff.

[c] $p < .05$ compared with participants with MH (among untreated participants) or MUCH (among treated participants) considering the same HBPM cutoff.

selection bias influenced the prevalence of the studied phenotypes. In this regard, patients who sought BP evaluation could have been more concerned about their BP levels, and therefore might have been under higher risk of having elevated BP levels, ultimately increasing the prevalence of abnormal BP phenotypes in our sample. Conversely, the large sample size and the multicenter nature of our protocol are strengths of the study.

In conclusion, this study showed that shifting the HBPM abnormal cutoff from 135/85 to 130/80 mmHg and keeping the office abnormal cutoff at 140/90 mmHg were associated with marked increases in the prevalence of out-of-office hypertension and uncontrolled hypertension phenotypes.

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CONFLICT OF INTEREST

ADMF, MAM-G, WSB, AAB, RDM, and ECDB are owners of the online TELEMRPA platform (Beliva, Brazil). ADMF, MAM-G, and WSB are consultants for Omron.

AUTHOR CONTRIBUTIONS

ADMF and WNJ conceived and designed the study, analyzed the data, interpreted results, and drafted the manuscript. MAM-G, WSB, RDM, ECDB, AAB, FN, DMJ, CA, JLL-F, and ACS analyzed the data, interpreted results, and edited and revised the manuscript. All gave final approval and agreed to be accountable for all aspects of work ensuring integrity and accuracy.

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