Prognostic Value of Masked Uncontrolled Hypertension
Systematic Review and Meta-Analysis

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See Editorial Commentary, pp 843–845

Abstract—The prognostic relevance of masked uncontrolled hypertension (MUCH) is incompletely clear, and its global impact on cardiovascular outcomes and mortality has not been assessed. The aim of this study was to perform a meta-analysis on the prognostic value of MUCH. We searched for articles assessing outcome in patients with MUCH compared with those with controlled hypertension (CH) and reporting adjusted hazard ratio and 95% CI. We identified 6 studies using ambulatory blood pressure monitoring (12 610 patients with 933 events) and 5 using home blood pressure measurement (17 742 patients with 394 events). The global population included 30 352 patients who experienced 1327 events. Selected studies had cardiovascular outcomes and all-cause mortality as primary outcome, and the main result is a composite of these events. The overall adjusted hazard ratio was 1.80 (95% CI, 1.57–2.06) for MUCH versus CH. Subgroup meta-analysis showed that adjusted hazard ratio was 1.83 (95% CI, 1.52–2.21) in studies using ambulatory blood pressure monitoring and 1.75 (95% CI, 1.38–2.20) in those using home blood pressure measurement. Risk was significantly higher in MUCH than in CH independently of follow-up length and types of studied events. MUCH was at significantly higher risk than CH in all ethnic groups, but the highest hazard ratio was found in studies, including black patients. Risk of cardiovascular events and all-cause mortality is significantly higher in patients with MUCH than in those with CH. MUCH detected by ambulatory or home blood pressure measurement seems to convey similar prognostic information. **(*Hypertension*. 2018;72:862-869. DOI: 10.1161/HYPERTENSIONAHA.118.11499.)** ● **Online Data Supplement**

Key Words: blood pressure ■ hypertension ■ masked hypertension ■ mortality ■ risk

Some individuals have normal clinic blood pressure (BP) but high out-of-office BP. This phenomenon has been named white-coat normotension,[1] isolated ambulatory or home hypertension,[2] reverse white-coat hypertension,[3] and lastly masked hypertension by Pickering et al in 2002.[4]

It has been detected in untreated subjects[5,6] and treated or mixed populations.[7–28] In specifically treated patients, this phenomenon has been described >10 years ago[7–10,15] and later renamed masked uncontrolled hypertension (MUCH).[16,29–31]

Among prospective studies,[7–28] including patients with MUCH, some[11–14,22,27] did not evaluate cardiovascular risk in untreated and treated subjects analysed separately, some[8,10,15,18,20,21,24,26,28] reported significant higher risk and some[7,9,16,17,23] not significant higher risk in patients with MUCH when compared with those with normal clinic and out-of-office BP (controlled hypertension [CH]), and others[19,25] reported different results depending on comorbidities.

Thus, the prognostic value of MUCH is not yet clear. To the best of our knowledge, previous reviews and meta-analyses[5,6,32–36] concerning masked hypertension evaluated untreated, treated, or mixed populations analysed together, and an analysis specifically assessing the prognostic value of MUCH is still lacking.

In addition, MUCH can be detected by using either ambulatory BP monitoring[7,9–16,18,19,21,23,24,26–28] or home BP measurement.[8,17,20,22,25] Although MUCH detected by ambulatory BP monitoring or home BP recording are not completely the same entity,[14] globally these methods describe a similar phenomenon, that is, normal clinic and high out-of-office BP.

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The aim of this study was to perform a meta-analysis on the prognostic value of MUCH diagnosed by ambulatory BP monitoring and home BP measurement.

Methods

The study was performed in accordance with the recommendations of the Meta-analysis of Observational Studies in Epidemiology Group.[37] Original studies were approved by the institutional review committees, and subjects gave informed consent. The data that support the findings of this study are available from the authors on reasonable request.

Search Strategy

We conducted a literature search through PubMed, Web of Science, and Cochrane Library for articles evaluating cardiovascular outcome in patients with MUCH in comparison with those with CH up to April 20, 2018. The terms used to identify studies were white-coat normotension, isolated ambulatory hypertension, isolated home hypertension, reverse white-coat hypertension, masked hypertension, masked uncontrolled hypertension, and prognosis or cardiovascular risk or cardiovascular outcome or cardiovascular events. Two reviewers (A.M. Pierdomenico and F. Coccina) independently screened titles and abstracts to identify eligible studies. Disagreement between the 2 reviewers was resolved by a third reviewer (S.D. Pierdomenico). Reference lists of included articles were also examined for additional studies. If necessary, supplementary data were obtained through personal contact with the investigators of the selected studies.

Eligibility Criteria

Inclusion criteria for entry in the present meta-analysis were (1) full-text article published in a peer-reviewed journal; (2) any language of publication; (3) study on adult population; (4) use of ambulatory BP monitoring or home BP recording; (5) prospective study; (6) follow-up of at least 1 year; (7) assessment of cardiovascular outcome and mortality (any end point, that is, composite or separate end points) in MUCH compared with CH; (8) availability of adjusted hazard ratio (HR); and 95% CI between MUCH and CH.

Study Selection, Data Extraction, and Quality Evaluation

The first literature search identified 1659 studies from various databases and 857 studies after removing duplicates. Of these, 31 were eligible after revision of titles and abstracts.[5–28,32–36,38,39] Seven studies[5,6,32–36] were excluded because they were previous narrative reviews or reviews, including untreated, treated, or mixed populations analysed together, 3 studies[11,14,27] were excluded because untreated and treated patients were analysed together (one of them[27] evaluated patients with chronic kidney disease), 2 studies[38,39] were excluded because they were included in another report,[20] and 1 study[21] was excluded because it evaluated hypertensive patients with chronic kidney disease (only a few studies specifically assessed populations with diabetes mellitus and chronic kidney disease; hence, because of the relatively small number of patients and events of these specific subpopulations, we did not include them in this meta-analysis). Thus, 18 studies[7–10,12,13,15–20,22–26,28] were included. Of these selected studies, 7 were joined in a single report[9,12,13,15,18,19,23] according to the data provided by the IDACO (International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes) investigators (L. Thijs and J.A. Staessen) and 2 others[10,26] were joined in a single report according to updated data (2013) provided by the authors of Chieti-Pescara Study (S.D. Pierdomenico, A.M. Pierdomenico, F. Coccina). Also for some other studies data were provided by the authors: D.L. Clement, M.L. De Buyzere, and D.A. De Bacquer for the OvA study (Office Versus Ambulatory Pressure),[7] I.Z. Ben-Dov for the Hadassah Study,[16] W. Vongpatanasin for the Dallas Heart Study,[22] and J.R. Banegas and L.M. Ruilope for the Spanish Registry Study.[28] Finally, 11 studies/joined data were selected for meta-analysis, 6 for MUCH detected by ambulatory BP monitoring,[7,16,24,28] joined data of IDACO study,[9,12,13,15,18,19,23] and joined data of Chieti-Pescara Study[10,26] and 5 for MUCH detected by home[8,17,20,22,25] BP measurement. Selection of publications is summarized in Figure 1.

Two reviewers (A.M. Pierdomenico and F. Coccina) independently extracted relevant data from selected studies. Disagreement between the 2 reviewers was resolved by a third reviewer (S.D. Pierdomenico).

The quality of included studies was assessed using the Newcastle-Ottawa scale.[40] This scale evaluates cohort studies based on (1) selection (representativeness of the exposed cohort, selection of the nonexposed cohort, ascertainment of exposure, demonstration that outcome of interest was not present at start of study; maximum 4 stars), (2) comparability (comparability of cohorts on the basis of the design or analysis; maximum 2 stars), and (3) outcome (assessment of outcome, follow-up length, adequacy of follow-up of cohorts; maximum 3 stars). The total maximum score can be 9.

Statistical Analysis

To address confounding from other risk factors, we used the adjusted HR and 95% CI of the individual studies to calculate the overall adjusted HR and 95% CI, as also previously performed.[5,33,34] We used the random effects model.[41] Tests of heterogeneity were performed using the Cochrane Q statistic and I^2 statistic.[42] Subgroup meta-analysis, which is equivalent to meta-regression with categorical (or categorized) variables, was also performed to analyze potential sources of heterogeneity.[43] Individual studies were removed 1 at a time to evaluate the influence of that study on the pooled estimate. A funnel plot, Begg, and Mazumdar[44] rank correlation test and Egger[45] regression test for funnel plot asymmetry were used to examine the likely presence of publication bias and small-study effect. Potential adjustment for missing studies was approached by Duval and Tweedie trim and fill method.[46] Statistical significance was defined as $P<0.05$ (2-tailed tests). Analyses were done using the Comprehensive Meta-Analysis software version 2 (Biostat, Englewood, NJ).

Results

Main characteristics of studies using ambulatory BP monitoring are reported in Table 1. The pooled population consisted of 12 610 patients who experienced 933 events. All the studies defined MUCH as clinic BP <140/90 mm Hg and daytime BP ≥135/85 mm Hg. Mean follow-up ranged from 4.7 to 11 years. Four studies evaluated fatal and nonfatal cardiovascular events (stroke, coronary artery disease, heart failure, and peripheral revascularization in 3 studies and stroke and coronary artery disease in 1 study), and two studies evaluated all-cause mortality.

Main characteristics of studies using home BP recording are reported in Table 2. The pooled population consisted of 17 742 patients who experienced 394 events. All the studies defined MUCH as clinic BP <140/90 mm Hg and home BP ≥135/85 mm Hg. Mean follow-up ranged from 2 to 9.4 years. All the studies evaluated fatal and nonfatal cardiovascular events (stroke, coronary artery disease, and heart failure in 3 studies and stroke and coronary artery disease in 2 studies). Globally, we included 30 352 patients who experienced 1327 events.

Other characteristics of studies are reported in Table S1 in the online-only Data Supplement. All of them assessed general hypertensive populations; indeed, studies or subanalyses evaluating specific populations, such as those with diabetes mellitus or chronic kidney disease, were not included. The prognostic value of MUCH was evaluated across various ethnicities. A similar set of covariates, including main cardiovascular risk factors, was used in multivariate analysis in the majority of studies and some studies used additional

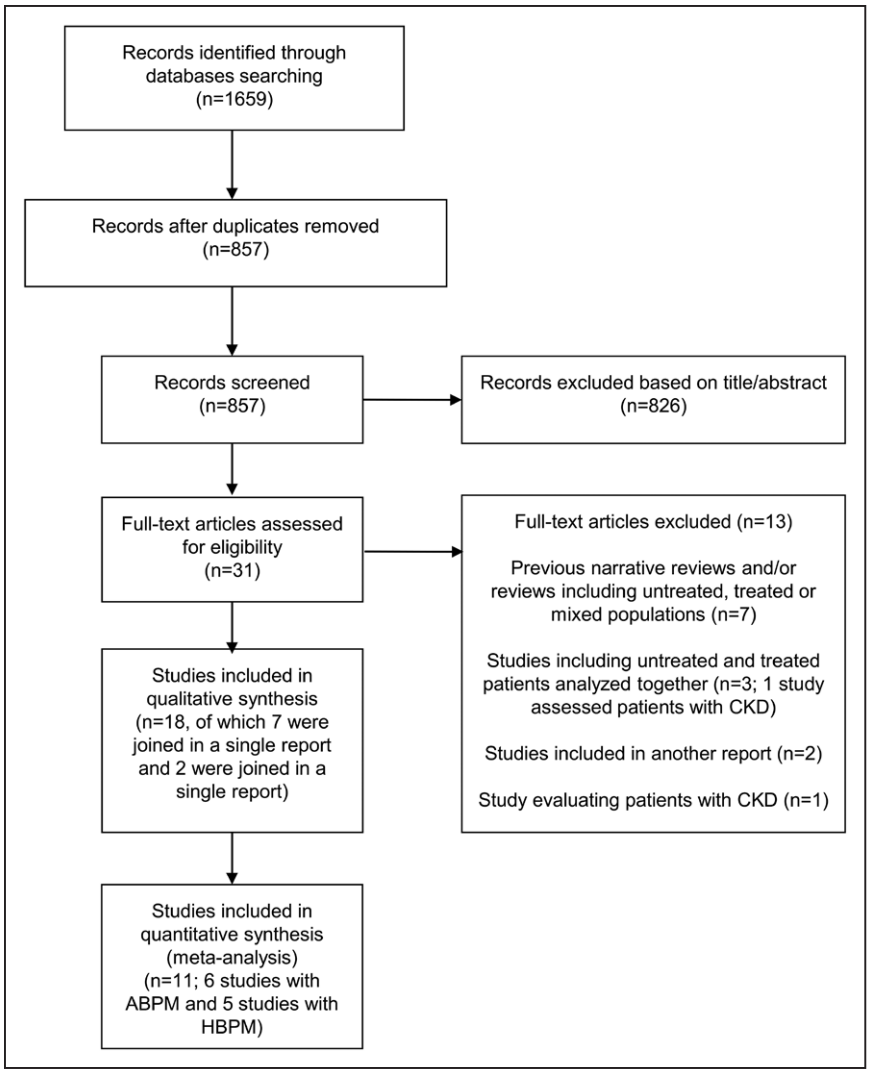

Figure 1. Flow chart showing selection of publications. ABPM indicates ambulatory blood pressure monitoring; CKD, chronic kidney disease; and HBPM, home blood pressure measurement.

covariates. According to the Newcastle-Ottawa scale, all the included studies were of high quality (Table S2).

Figure 2 gives the adjusted HR and 95% CI of the individual studies and of the overall analysis between MUCH and CH. The overall adjusted HR was 1.80 (95% CI, 1.57–2.06; P=0.0001) for MUCH versus CH. The degree of heterogeneity of the HR estimates across the studies (I^2 and τ) were modest and statistically nonsignificant (P=0.20 for the Q statistic). To further explore this aspect, subgroup meta-analysis was performed according to the method of BP measurement, follow-up length, type of event, and ethnicity (Table 3). The adjusted HR was 1.83 (95% CI, 1.52–2.21) for studies using ambulatory BP monitoring and 1.75 (95% CI, 1.38–2.20) for studies using home BP measurement with no significant difference between subgroups. Risk was significantly higher in MUCH than in CH in studies with a mean follow-up shorter or longer than 5 years and in studies evaluating different types of composite events or all-cause mortality, and no significant difference was found among specific subgroups (Table 3). As far as ethnicity, we found some heterogeneity among subgroups. Indeed, though MUCH was always at significantly higher risk than CH, the lowest HR was found in studies including Asian patients only and the highest HR was found in studies including black patients (Table 3). If 1 study,[25] in which categorization of patients by home BP was somehow different from others, was excluded the results on overall analysis and subgroup analysis by BP measurement method, follow-up length, and types of events did not substantially change; on the contrary, there was no more heterogeneity among ethnic subgroups. Sensitivity analysis indicated that none of the studies had a significant influential effect on the overall estimate in both the global analysis (Figure S1) and the analysis evaluating studies with ambulatory BP monitoring and home BP measurement separately (Figure S2). When we explored for publication bias and small-study effect, the Begg and Mazumdar and Egger tests did not attain statistical significance (all 2-tailed P>0.5). However, when we applied Duval and Tweedie trim and fill method, 1 study appeared missing to the left side of the mean effect, and the imputed point estimate was 1.76; 95% CI, 1.52 to 2.03. (Figure S3).

Discussion

This meta-analysis shows that risk of cardiovascular events and all-cause mortality is significantly higher in patients with MUCH than in those with CH. Moreover, MUCH detected by ambulatory BP monitoring or home BP measurement seems

Table 1. Main Characteristics of Selected Studies Using Ambulatory BP Monitoring

Study	Patients		MUCH Definition	FU, y	Events		Type of Event
	CH	MUCH			CH	MUCH	
OvA Study, 2003[7]	146	143	Day BP ≥135/85 mm Hg	5	7	9	Fatal/nonfatal CVE
Chieti-Pescara Study, 2005–2017[10,26]	523	215	Day BP ≥135/85 mm Hg	10	79	69	Fatal/nonfatal CVE
IDACO Study, 2005–2017[9,12,13,15,18,19,23]	528	236	Day BP ≥135/85 mm Hg	11	147	93	Fatal/nonfatal CVE
Hadassah Study, 2008[16]	360	268	Day BP ≥135/85 mm Hg	7.7	23	29	All-cause mortality
Jackson Heart Study, 2016[24]	272	135	Day BP ≥135/85 mm Hg	8.2	16	22	Fatal/nonfatal CVE
Spanish Registry Study, 2018[28]	7406	2378	Day BP ≥135/85 mm Hg	4.7	273	166	All-cause mortality

Data of the OvA, IDACO, Hadassah, and Spanish Registry Studies are provided by the authors. Data of the Chieti-Pescara Study, provided by the authors, come from the overall database of treated hypertensive patients at baseline (2264 patients) which includes patients aged ≥ 60 y reported in Pierdomenico et al[26], those aged <60 y reported in Pierdomenico et al[10] and other patients aged <60 y of the database (data of patients aged ≥ and <60 y are equally updated to 2013); the cutoff of daytime BP to define MUCH was chosen for homogeneity with other studies. Data of the Jackson Heart Study are published data. Daytime BP recording interval: OvA study (30 min), Chieti-Pescara Study (15 min), IDACO study (15–30 min), Hadassah Study (20 min), Jackson Heart Study (20 min), and Spanish Registry Study (20 min). Follow-up data are given as mean. Cardiovascular events include stroke, coronary artery disease, heart failure, and peripheral revascularization for OvA, Chieti-Pescara, and IDACO Studies and stroke and coronary artery disease for Jackson Heart Study. BP indicates blood pressure; CH, controlled hypertension; CVE, cardiovascular events; FU, follow-up; IDACO, International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes; MUCH, masked uncontrolled hypertension; and OvA, Office Versus Ambulatory Pressure.

to convey similar prognostic information, though some differences exist across the studies.

To the best of our knowledge, this is the first meta-analysis specifically evaluating the prognostic value of MUCH. Indeed, previous ones evaluated the prognostic value of masked hypertension in untreated patients[5,6] or untreated, treated, and mixed populations analysed together.[33,34,36] Fagard and Cornelissen,[33] executed a meta-analysis of 7 studies. The adjusted HR of masked hypertension versus normotension was 2.0 (95% CI, 1.58–2.52). The aim of the study was to include subjects coming from the same population, and the authors had to select reports evaluating untreated, treated,[8,10] or mixed cohorts that were analysed together in the meta-analysis. Bobrie et al[34] performed a meta-analysis of 6 studies. Compared with normotension, the overall adjusted HR was 1.92 (95% CI, 1.51–2.44) for masked hypertension. Among selected studies, 1 had been performed in untreated subjects, 2[8,10] in treated subjects, and 3 in mixed populations that were analysed together in the meta-analysis. Palla et al[36] published a meta-analysis in which the impact of masked hypertension in comparison with normotension in treated subjects was also evaluated. Four studies[9,11,19,20] for cardiovascular events and 3 studies[19,20,24] for mortality were

Table 2. Main Characteristics of Selected Studies Using Home BP Recording

Study	Patients		MUCH Definition	FU, y	Events		Type of Event
	CH	MUCH			CH	MUCH	
SHEAF Study, 2004[8]	685	462	Home BP ≥135/85 mm Hg	3.2	23	41	Fatal/nonfatal CVE
J-HEALTH Study, 2008[17]	689	566	Home BP ≥135/85 mm Hg	3.5	5	9	Fatal/nonfatal CVE
IDHOCO Study, 2014[20]	328	232	Home BP ≥135/85 mm Hg	8.3	57	66	Fatal/nonfatal CVE
Dallas Heart Study, 2015[22]	171	122	Home BP ≥135/85 mm Hg	9.4	17	37	Fatal/nonfatal CVE
HONEST Study, 2017[25]	8608*	5879*	Home BP ≥135/85 mm Hg	2.0	64†	75†	Fatal/nonfatal CVE

Data of the Dallas Heart Study are provided by the authors. Data of the SHEAF, J-HEALTH, and IDHOCO Studies are published data. Home BP in the SHEAF study: 3 consecutive readings in the morning and in the evening for a 4-day period. Home BP in the J-HEALTH study: 1 reading in the morning (each mo, usually on the day of attending hospital) during 6 mo of treatment (thereafter, patients were categorized in various subgroups). Home BP in the IDHOCO study (including 5 studies): 2 consecutive readings in the morning and in the evening on 7 consecutive days in 1 study; 1 reading in the morning for 4 wk in 1 study; 2 consecutive readings in the morning and in the evening for 3 days in 1 study; 3 consecutive readings in the morning and in the evening for 5 consecutive days in 1 study; mean of all morning measurements in 1 study. Home BP in the Dallas Heart Study: mean of the third to fifth BP measurements. Home BP in the HONEST study: 2 consecutive readings in the morning on 2 different days at 4 and 16 wk, and 6, 12, 18, and 24 mo. Follow-up data are given as mean. Cardiovascular events include stroke, coronary artery disease, and heart failure for SHEAF, IDHOCO, and Dallas Heart Studies, and stroke and coronary artery disease for J-HEALTH and HONEST studies. BP indicates blood pressure; CH, controlled hypertension; CVE, cardiovascular events; FU, follow-up; HONEST, Home Blood Pressure Measurement With Olmesartan Naive Patients to Establish Standard Target Blood Pressure; IDHOCO, International Database on Home Blood Pressure in Relation to Cardiovascular Outcome; J-HEALTH, Japan Hypertension Evaluation With Angiotensin II Antagonist Losartan Therapy; MUCH, masked uncontrolled hypertension; and SHEAF, Self-Measurement of Blood Pressure at Home in the Elderly: Assessment and Follow-Up.

*Patients without diabetes mellitus (including those with chronic kidney disease) plus patients with diabetes mellitus (including those with chronic kidney disease).

†The event number is calculated considering the event rate per 1000 person/years in each group, the number of patients in each group and the mean duration of follow-up (data derived from Kushiro et al[25]).

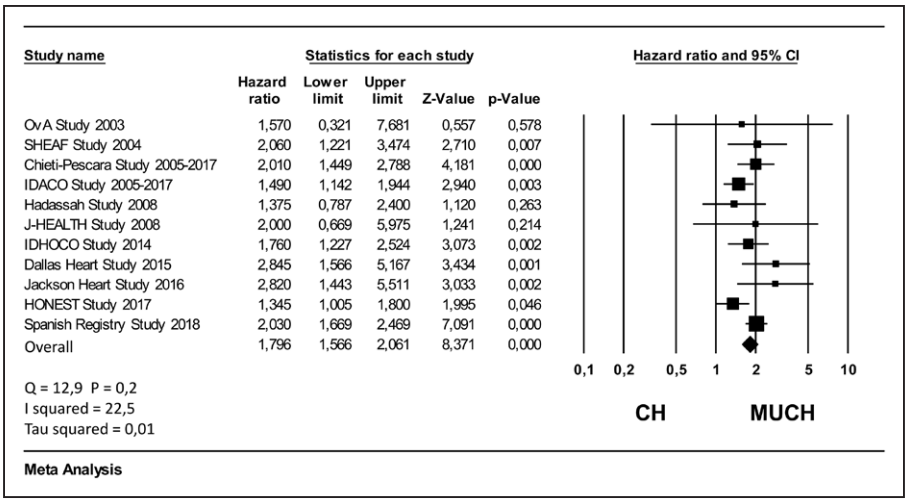

Figure 2. Forest plot showing the adjusted hazard ratio and 95% CI between patients with masked uncontrolled hypertension (MUCH) and those with controlled hypertension (CH). Data of the OvA (Office Versus Ambulatory Pressure), Chieti-Pescara, IDACO (International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes), Hadassah, Spanish Registry, and Dallas Heart Studies are provided by the authors. Data of the HONEST study (Home Blood Pressure Measurement With Olmesartan Naive Patients to Establish Standard Target Blood Pressure) are derived from Kushiro et al[25]; they are a pooled estimate of values of MUCH patients without diabetes mellitus (including those with chronic kidney disease) and of MUCH patients without chronic kidney disease (including those with diabetes mellitus). Data of the SHEAF (Self-Measurement of Blood Pressure at Home in the Elderly: Assessment and Follow-Up), J-HEALTH (Japan Hypertension Evaluation With Angiotensin II Antagonist Losartan Therapy), IDHOCO (International Database on Home Blood Pressure in Relation to Cardiovascular Outcome), and Jackson Heart Studies are published data.

included. Compared with normotension, the odds ratio was 2.03 (95% CI, 1.52–2.72) concerning cardiovascular events and 1.44 (95% CI, 1.03–2.01) concerning mortality for masked hypertension. However, the selected studies were substantially heterogeneous; indeed, among them, 1 included a mixed population,[11] and 1 included selected populations.[19] Moreover, other studies evaluating patients with MUCH were not included.[7,8,10,16,17,22,25] Finally, the odds ratio, and not the adjusted HR, was calculated. The above-mentioned meta-analyses[33,34,36] have been of relevance in trying to address the prognostic value of masked hypertension in untreated and treated subjects. However, compared with them,[33,34,36] our study included only treated patients comprising those with MUCH and CH and analysed studies that were homogeneous about hypertensive population type. Moreover, we had the opportunity to pool together the data obtained directly by the authors of various studies. This aspect makes our meta-analysis the largest available about the prognostic value of MUCH.

MUCH could depend on various conditions, including smoking habit, alcohol consumption, BP response to physical activity, psychological stress, some comorbidities, different effect of therapy on office and out-of-office BP (it has been reported that a 3 mm Hg office systolic BP reduction equates approximately to 2 mm Hg out-of-office systolic BP reduction), clinic BP recorded at the peak of antihypertensive effect, insufficient prescribed doses, and incomplete adherence to treatment.[30–32,35] Whatever the reason, the first purpose is to identify MUCH which is associated with increased cardiovascular risk and then to control out-of-office BP by correcting potential factors contributing to MUCH in the patient.

Recent guidelines[47] recommend measurement of out-of-office BP for confirmation and management of hypertension, given the superiority of out-of-office BP over clinic BP in predicting prognosis. The findings of the present study further support the relevance of out-of-office BP in the prognostic stratification of patients. At present, however, studies showing the superiority of out-of-office BP control over clinic BP control in reducing cardiovascular risk are still lacking.

The present study has some limitations. First, the set of events evaluated in the single studies was not exactly the same; however, when subgroup meta-analysis was performed taking into account the type of cardiovascular events and all-cause mortality, the risk was always significantly higher in patients with MUCH. Second, a minority of subjects (<0.5% of the global population) has been included in both the IDACO[9,12,13,15,18,19,23] and IDHOCO studies (International Database of Home Blood Pressure in Relation to Cardiovascular Outcome)[20]; however, given the relatively small number of patients, we think this aspect has not significantly affected the results. Third, data of the HONEST study (Home Blood Pressure Measurement With Olmesartan Naive Patients to Establish Standard Target Blood Pressure)[25] were extrapolated from the article. Fourth, the HONEST study[25] used categorization of patients by home BP that was somehow different from other studies; however, if that study was excluded from analysis, the overall result did not substantially change.

Perspectives

This meta-analysis shows that patients with MUCH have significantly higher risk of cardiovascular events and all-cause mortality than those with CH and that MUCH detected by ambulatory BP monitoring or home BP measurement appears to convey prognostic information of similar magnitude. Thus, every effort should be made to detect this condition and to identify the best therapeutic approach. In such a context, future studies are needed, such as the MASTER study (Masked-Uncontrolled Hypertension Management Based on Office BP or on Out-of-Office [ambulatory] BP Measurement),[48] to evaluate whether out-of-office BP control improves cardiovascular outcome in these patients.

Table 3. Random Effects Meta-Analysis According to the Method of BP Measurement, Follow-Up Length, Type of Composite Event and Ethnicity in the Comparison Between Masked Uncontrolled Hypertension and Controlled Hypertension

Variable	Studies	Subjects/Events	Adjusted HR (95% CI)	*P* Value
Method of BP measurement				
ABPM*†‡§‖¶	6	12 610/933	1.83 (1.52–2.21)	0.75
HBPM#**††‡‡§§	5	17 742/394	1.75 (1.38–2.20)	
Mean follow-up length				
≤5 y*¶#**§§	5	26 962/672	1.77 (1.41–2.22)	0.82
>5 y†‡§‖††‡‡	6	3390/655	1.83 (1.49–2.24)	
Type of composite event				
Stroke+CAD+HF+PR*†‡	3	1791/404	1.70 (1.27–2.27)	0.76
Stroke+CAD+HF#††‡‡	3	2000/241	2.06 (1.49–2.84)	
Stroke+CAD‖**§§	3	16 149/191	1.64 (1.16–2.31)	
All-cause mortality§¶	2	10 412/491	1.85 (1.36–2.51)	
Ethnicity				
White only*†§¶#	5	12 586/719	1.96 (1.69–2.29)	0.02
Asian only**§§	2	15 742/153	1.38 (1.04–1.83)	
Black included‖‡‡	2	700/92	2.83 (1.81–4.42)	
White, Asian, Hispanic‡††	2	1324/363	1.58 (1.28–1.96)	

ABPM indicates ambulatory BP monitoring; BP, blood pressure; CAD, coronary artery disease; HBPM, home BP measurement; HF, heart failure; HONEST, Home Blood Pressure Measurement With Olmesartan Naive Patients to Establish Standard Target Blood Pressure; HR, hazard ratio; IDACO, International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes; IDHOCO, International Database on Home Blood Pressure in Relation to Cardiovascular Outcome; J-HEALTH, Japan Hypertension Evaluation With Angiotensin II Antagonist Losartan Therapy; OvA, Office Versus Ambulatory Pressure; PR, peripheral revascularization; and SHEAF, Self-Measurement of Blood Pressure at Home in the Elderly: Assessment and Follow-Up.

*OvA study.
†Chieti-Pescara Study.
‡IDACO study.
§Hadassah Study.
‖Jackson Heart Study (included 100% black patients).
¶Spanish Registry Study.
#SHEAF study.
**J-HEALTH study.
††IDHOCO study.
‡‡Dallas Heart Study (included 50% black patients).
§§HONEST study.

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Disclosures

None.

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Novelty and Significance

What Is New?

- This is the first meta-analysis evaluating cardiovascular outcome and mortality in patients with masked uncontrolled hypertension.
- The present study pooled together data obtained in a very large population (30 352 patients) experiencing many events (1327).

What Is Relevant?

- This study provides evidence that in treated patients with normal clinic blood pressure (BP) the evaluation of out-of-office BP is of relevance for risk stratification.
- This study supports that future randomized trials should be conducted to evaluate whether out-of-office BP control improves outcome in patients with masked uncontrolled hypertension.

Summary

This meta-analysis shows that risks of cardiovascular events and all-cause mortality are significantly higher in patients with masked uncontrolled hypertension than in those with controlled hypertension. Masked uncontrolled hypertension detected by ambulatory BP monitoring or home BP measurement appears to convey similar prognostic information.