# Prevalence and Determinants of Masked Hypertension Among Black Nigerians Compared With a Reference Population

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*Abstract*—Hitherto, diagnosis of hypertension in sub-Saharan Africa was largely based on conventional office blood pressure (BP). Data on the prevalence of masked hypertension (MH) in this region is scarce. Among individuals with normal office BP (<140/90 mmHg), we compared the prevalence and determinants of MH diagnosed with self-monitored home blood pressure (≥135/85 mmHg) among 293 Nigerians with a reference population consisting of 3615 subjects enrolled in the International Database on Home Blood Pressure in Relation to Cardiovascular Outcomes. In the reference population, the prevalence of MH was 14.6% overall and 11.1% and 39.6% in untreated and treated participants, respectively. Among Nigerians, the prevalence standardized to the sex and age distribution of the reference population was similar with rates of 14.4%, 8.6%, and 34.6%, respectively. The mutually adjusted odds ratios of having MH in Nigerians were 2.34 (95% confidence interval, 1.39–3.94) for a 10-year higher age, 1.92 (1.11–3.31) and 1.70 (1.14–2.53) for 10- or 5-mmHg increments in systolic or diastolic office BP, and 3.05 (1.08–8.55) for being on antihypertensive therapy. The corresponding estimates in the reference population were similar with odds ratios of 1.80 (1.62–2.01), 1.64 (1.45–1.87), 1.13 (1.05–1.22), and 2.84 (2.21–3.64), respectively. In conclusion, MH is as common in Nigerians as in other populations with older age and higher levels of office BP being major risk factors. A significant proportion of true hypertensive subjects therefore remains undetected based on office BP, which is particularly relevant in sub-Saharan Africa, where hypertension is now a major cause of death. (*Hypertension*. 2016;67:1249-1255. DOI: 10.1161/HYPERTENSIONAHA.116.07242.)

Key Words: home blood pressure monitoring ■ masked hypertension ■ special populations

Energing epidemiological data indicate that cardiovascular disease is now the major challenge to public health in sub-Saharan Africa.<sup>1,2</sup> Hypertension, the major risk factor for stroke, heart failure, and chronic kidney disease, is the main driver of this epidemic. Most,<sup>3-6</sup> although not all,<sup>7,8</sup> cross-sectional data from different areas of sub-Saharan Africa<sup>3-6</sup> aimed at evaluating the burden of high blood pressure (BP) defined

hypertension solely on the basis of clinic BP. This excludes a substantial number of individuals who have hypertension that is masked to conventional office measurement.<sup>9</sup> Masked hypertension, however, is not an innocuous clinical state as recent outcome studies clearly demonstrated that masked hypertension and sustained hypertension confer similar risks in terms of cardiovascular risk.<sup>10,11</sup>

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Published data overwhelmingly show that the prevalence of hypertension and the rate of BP-related complications are substantially higher among blacks than they are among whites.<sup>12</sup> Most of these studies contrasted blacks from African ancestry with whites in the United States. However, we recently reported that the prevalence of hypertension on conventional BP measurement, amounted to 13.3% and 28.9%, respectively, among South Africans and Flemish whites and to 34.1% among black South Africans.<sup>13</sup> From this perspective, the hypothesis that masked hypertension might be more prevalent among blacks born and living in Africa had to be tested. We therefore investigated the prevalence and determinants of masked hypertension in an urban community of Nigeria and compared our findings in black Nigerians with a large reference population enrolled in the International Database on Home Blood Pressure in Relation to Cardiovascular Outcome (IDHOCO).14,15

## Methods

#### **Study Population**

The black African population consists of Nigerians recruited in the framework of the ongoing Nigerian Population Research on Environment Gene and Health (NIPREGH).<sup>16,17</sup> Eligible people must be living in a well-delineated housing estate in Abuja, Nigeria.<sup>16</sup> The University of Abuja Teaching Hospital Health Research Ethics Committee approved NIPREGH. The study complies with guidelines for research involving human subjects as outlined in the Helsinki declaration.<sup>18</sup> The reference population consisted of 4 population cohorts enrolled in IDHOCO.14,15 They were chosen because their age distribution best approximated that of the NIPREGH participants. All studies included in IDHOCO received ethical approval from the competent national or institutional ethical review boards and have been described in peer-reviewed publications.19-22 The Asian population were community dwelling adults aged  $\geq$ 35 years living in Ohasama, Iwate Prefecture, Northern Japan.<sup>19</sup> The age-stratified South American cohort included members of a health insurance medical care institution in Montevideo Uruguay.20 The Europeans were either Finns aged between 45 and 74 years who participated in a nationwide health survey in Finland<sup>22</sup> or Greeks aged ≥18 years living in Didima, located in Argolida of Peloponnesus in southern Greece.21

From the NIPREGH<sup>16</sup> and IDHOCO<sup>19-22</sup> cohorts, we selected subjects who were normotensive by office measurement (BP <140 mm Hg systolic and <90 mm Hg diastolic), irrespective of whether they were receiving antihypertensive medication.

#### Measurements

In the Nigerian study,<sup>16</sup> trained observers measured office BP by auscultation of the Korotkoff sounds, according to the guideline of the European Society of Hypertension.23 After the participants had rested in the sitting position for at least 10 minutes, the observers obtained 5 consecutive BP readings, using a standard mercury sphygmomanometer (Accuson) applied to the nondominant arm. Systolic and diastolic (phase V) pressures were determined to the nearest 2 mmHg. Standard cuffs had a 12×24 cm inflatable portion, but if upper arm girth exceeded 32 cm, larger cuffs with 15×35 cm bladders were used. We ensured high quality of BP measurements<sup>17</sup> by applying the same methodology as implemented and validated in the European Project on Genes in Hypertension.<sup>24</sup> To keep consistency with the procedures followed in IDHOCO,19-22 for the current analysis, we used the average of the first 2 BP readings. After conventional BP measurement, each NIPREGH participant was trained on how to measure BP at home, using a validated25 semiautomated oscillometric device (Omron 705 IT; Hoofddorp, The Netherlands). To demonstrate the measurement technique,16 the participants were invited to take 2 consecutive measurements immediately after the oral explanation. Next, the monitor was handed over the participant together with a diary card for recording the self-measured BP at home. In line with European guidelines,<sup>23</sup> participants were asked to record their BP on 7 consecutive days 2 times in the morning between 6 AM and 8 AM and 2 times in the evening between 7 PM and 9 PM. Home BP was the average of all self-measured readings.

Details on the procedures of BP measurement in the IDHOCO reference population are presented elsewhere.<sup>14,15</sup> Briefly, office BP was measured with a standard mercury sphygmomanometer (Mercuro 300<sup>22</sup> or Baumomanometer<sup>21</sup>), an automatic auscultatory Elquest USM-700F<sup>19</sup> or a validated oscillometric monitor (Omron HEM-705CP),<sup>20</sup> using the appropriate sized cuff with the subject in the sitting position. The conventional BP was the average of the first 2 readings. Home BPs were measured after 2–5 minutes of rest in a sitting position, with validated oscillometric devices (Omron HEM-722C,<sup>22</sup> Omron HEM-705CP,<sup>21</sup> Omron HEM-401C,<sup>19</sup> or SpaceLabs 90207<sup>20</sup>), fitted with the appropriate sized cuff. To be included in the analysis, a participant must have at least 2 home pressure readings and each participant's home BP was the average of all the available readings.

Participants were classified as having a high normal office BP if levels were 130 to 139 mmHg systolic or 85 to 89 mmHg diastolic. Masked hypertension was a normal office BP in the presence of a home BP of 135 mmHg systolic or 85 mmHg diastolic or more.

Questionnaires were used in both cohorts to obtain information on each participant's medical history, lifestyle habits including cigarette smoking and alcohol consumption, and intake of medications. Body mass index was body weight (kg) divided by height (m<sup>2</sup>).

#### **Statistical Analysis**

SAS software (SAS institute, Cary, NC) version 9.3 was used for database management and statistical analysis. The central tendency and spread of the data were reported as mean and SD. We compared mean values and proportions using Student t test or ANOVA and the  $\chi^2$  statistic, respectively. Statistical significance was a P value <0.05 on 2-sided tests. The prevalence of masked hypertension was standardized by the direct method for sex and age group (<40 versus  $\geq$ 40 years). We determined the correlates of masked hypertension in the Nigerian and reference population using both univariate and multivariable logistic regression. In the reference population, we accounted for cohort using dummy coding. Goodness of fit was checked using the Hosmer and Lemeshow test with 10 groups. We plotted the probability of masked hypertension against the continuous variables found to be significant in the multivariable-adjusted analysis, either as continuous risk functions or by fourths of the distributions of the explanatory variables.

#### Results

## **Characteristics of Participants**

The study population consisted of 293 Nigerian blacks and 3615 IDHOCO participants, including 1762 Asians (48.7%), 1527 Europeans (42.2%), and 326 South Americans of white European descent (9.0%). The Nigerian cohort were younger with an average age ( $\pm$ SD) of 39.2 $\pm$ 10.8 years as compared with 54.7 $\pm$ 13.0 years in the reference population (*P*<0.0001). Among Nigerians, only 5 participants (1.7%) reported smoking and 90 (30.7%) consumed alcohol. Among IDHOCO participants, these numbers were 848 (23.5%) and 1385 (48.5%), respectively (*P*<0.0001). The median number of readings (25th–75th percentile interval) averaged to estimate the home BP was 28 (24–28) and 28 (15–51) in Nigerians and the reference population, respectively.

Among Nigerians and the reference population, compared with normotensive participants, masked hypertensive patients were older and had higher body mass index and higher levels of office and home systolic and diastolic pressures (P < 0.05). In both populations, however, heart rate in normotensive people and masked hypertensive patients was similar ( $P \ge 0.05$ ; Table 1).

	Nigerians		Reference Population			
Characteristics	Normotension	Masked Hypertension	Normotension	Masked Hypertension		
Category, n	265	28	3086	529		
Characteristic, n (%)						
Women	126 (47.6)	15 (53.6)	1941 (62.9)	251 (47.4)*		
Smoking	4 (1.5)	1 (3.6)	696 (22.6)	152 (28.7)†		
Drinking alcohol	82 (31.3)	8 (28.6)	1134 (46.9)	251 (56.8)‡		
Office pressure ≥130/85 mm Hg	22 (8.3)	9 (32.1)‡	854 (27.7)	302 (57.1)*		
Antihypertensive medication	26 (9.8)	13 (46.4)*	269 (8.7)	176 (33.3)*		
Characteristic, mean±SD						
Age, y	38.1±10.0	49.7±12.5*	53.4±13.0	62.3±10.7*		
Body mass index, kg/m <sup>2</sup>	25.9±4.8	28.1±3.8§	24.6±3.7	27.0±5.1*		
Office systolic pressure, mm Hg	109.6±11.6	122.2±9.6*	119.6±11.7	128.1±8.4*		
Office diastolic pressure, mm Hg	70.2±8.9	77.6±8.2*	72.5±8.5	76.2±8.8*		
Home systolic pressure, mm Hg	112.7±10.1	132.9±9.2*	114.6±10.2	140.2±9.0*		
Home diastolic pressure, mm Hg	72.2±6.6	85.1±6.8*	70.5±7.2	84.4±6.9*		
Heart rate, bpm	70.1±10.0	73.7±8.1	69.9±10.0	69.6±10.4		

Table 1. Characteristics of Participants by Population and Hypertension Status

All participants had an office blood pressure <140 mm Hg systolic and <90 mm Hg diastolic. Patients with masked hypertension had a home blood pressure of  $\geq$ 135 mm Hg systolic or  $\geq$ 85 mm Hg diastolic. Information on alcohol intake was not available in 3 Nigerians and in 757 subjects from the reference population. Significance of the difference between normotension and masked hypertension: \**P*<0.0001, †*P*<0.001, and §*P*<0.05.

## **Prevalence of Masked Hypertension**

Among Nigerians, 28 had masked hypertension, of whom 13 (46.4%) were on antihypertensive treatment. Of 529 masked hypertensive patients in the reference population, 176 (33.3%) were taking BP-lowering drugs. The prevalence of masked hypertension in the reference population was 14.6% (95% confidence interval [CI], 13.5–15.8) overall and 11.1% (95% CI, 10.0–12.2) and 39.6% (95% CI, 35.0–44.1) in untreated and treated participants, respectively. Among Nigerians, the prevalence of masked hypertension standardized to the sex and age distribution of the reference population was similar with an overall rate of 14.4% (95% CI, 8.9–20.0; *P* for the difference with the reference population=0.95) and rates of 8.6% (95% CI, 3.7–13.5; *P*=0.32) and 34.6% (95% CI, 16.4–52.7; *P*=0.59) in untreated and treated NIPREGH participants, respectively (Figure 1).

## **Risk Factors for Masked Hypertension**

In the reference population, in both single- and multivariableadjusted logistic analysis (Table 2), the odds of masked hypertension were positively and significantly (P<0.05) associated with male sex, older age, higher body mass index, diabetes mellitus, higher systolic and diastolic office BP, intake of antihypertensive medications, and cigarette smoking. In the Nigerian population, the odds of having masked hypertension independently increased with older age (P=0.0013), higher systolic (P=0.021) and diastolic (P=0.0097) office BP, and intake of antihypertensive medications (P=0.036). The Hosmer and Lemeshow goodness-of-fit test indicated that the multivariate models fitted the data well (P=0.74 and P=0.55 in the IDHOCO and Nigerian population, respectively). The unadjusted and mutually adjusted odds ratios for age (P=0.14 and P=0.22, respectively), systolic BP (P=0.13 and P=0.62), diastolic BP (P=0.08 and P=0.12), and intake of antihypertensive drugs (P=0.30 and P=0.90) were similar in the Nigerian and reference populations.

With standardization as indicated in the legend to Figure 2 the predicted probability for a Nigerian having masked hypertension increased from 1.6% (95% CI, 0.2–10.5) in the lower age quartile (mean 26.8 years) to 18.6% (95% CI, 10.4–30.8) in the upper quartile (53.8 years). NIPREGH participants in the lower quartile of the conventional systolic (96.0 mmHg) and



**Figure 1.** Prevalence of masked hypertension among Nigerians (open bars) compared with the reference population (closed bars). The prevalence rates in Nigerians were standardized to the sex and age distribution of the reference population.

	Unadjusted Odds Ratios (95% Confidence Interval)		Multivariable-Adjusted Odds Ratios (95% Confidence Interval)	
Risk Factors	Reference	Nigerians	Reference	Nigerians
Cases/at risk (%)	529/3615 (14.6)	28/293 (9.6)	529/3615 (14.6)	28/293 (9.6)
Being female (0, 1)	0.52 (0.44–0.63)*	1.27 (0.58–2.78)	0.62 (0.49–0.77)*	1.51 (0.57–3.97)
Age (+10 y)	1.89 (1.72–2.06)*	2.51 (1.72–3.64)*	1.80 (1.62–2.01)*	2.34 (1.39–3.94)†
Body mass index (+5 kg/m²)	2.18 (1.92–2.48)*	1.58 (1.07–2.32)‡	1.98 (1.71–2.29)*	1.38 (0.82–2.33)
Obesity (0, 1)	4.18 (3.18–5.49)*	2.22 (0.97–5.09)	1.37 (0.90–2.09)	1.79 (0.66–4.85)
Diabetes (0, 1)	2.67 (1.97–3.62)*	3.84 (1.14–13.0)‡	1.54 (1.08–2.17)‡	0.85 (0.17-4.19)
Systolic pressure (+10 mm Hg)	2.16 (1.94–2.40)*	3.08 (1.98–4.79)*	1.64 (1.45–1.87)*	1.92 (1.11–3.31)‡
Diastolic pressure (+5 mm Hg)	1.33 (1.25–1.41)*	1.70 (1.30–2.21)*	1.13 (1.05–1.22)†	1.70 (1.14–2.53)†
High normal office pressure (0, 1)	3.27 (2.70–3.96)*	5.23 (2.12–12.9)§	1.13 (0.82–1.55)	0.57 (0.16–2.11)
Antihypertensive treatment (0, 1)	5.02 (4.02-6.28)*	7.97 (3.42–18.6)*	2.84 (2.21–3.64)*	3.05 (1.08–8.55)‡
Smoking (0, 1)	1.41 (1.14–1.73)†		1.91 (1.48–2.47)*	
Drinking alcohol (0, 1)	1.38 (1.08–1.76)‡	0.88 (0.37–2.08)	1.13 (0.84–1.52)	0.78 (0.27–2.23)

Table 2.	Odds of Having Masked	Hypertension in	Nigerians and in th	e Reference Population
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Risk of masked hypertension associated with individual risk factors in 293 Nigerians and 3615 reference subjects from the International Database on Home Blood Pressure in Relation to Cardiovascular Outcome. The multivariable analysis was a stepwise logistic model that included all the factors significant in the univariate analysis. In the reference group, the model was adjusted for cohort using dummy coding. The *P* value to enter and stay in the model was set at 0.15 and 0.05, respectively. For variables not entering the models hazard ratios adjusted for significant covariables are given. High normal office pressure is systolic pressure >130 mm Hg or diastolic pressure >85 mm Hg. Obesity is a body mass index  $\ge$ 30 kg/m<sup>2</sup>. An ellipsis indicates that smoking was not considered because of low prevalence (1.7%) in Nigerians. Significance of the odds ratios: \**P*<0.0001, ‡*P*<0.01, ‡*P*<0.001.

diastolic BP (59.0 mm Hg) had a 3.9% (95% CI, 0.5–24.3) and 11.8% (95% CI, 2.8–38.4) predicted probability for masked hypertension. In the upper quartiles (125.8 mm Hg systolic and 82.0 mm Hg diastolic), these probabilities increased to 29.5% (95% CI, 16.2–47.5) and 46.3% (95% CI, 26.3–67.7), respectively. The probability of a Nigerian having masked hypertension was similar to that of an individual of the reference population exposed to the same level of the risk factors, except in the upper 2 quartiles of systolic BP and in the upper quartile of diastolic BP (Figure 2). In the latter subgroups the adjusted probability of masked hypertension was higher in Nigerians than in the reference population (P<0.02).

## Discussion

The key findings of our study were that the sex- and age-adjusted prevalence of masked hypertension, irrespective of treatment status, was similar among black Nigerians and Japanese and white people of the reference group. In both Nigerians and the reference sample, older age and higher systolic and diastolic office BP increased the risk of having masked hypertension.

A quantitative review of published summary statistics addressed the prevalence of masked hypertension.<sup>26</sup> Overall the prevalence of masked hypertension averaged 16.8%; 95% CI, 13.0–20.5). The prevalence increased from 6.8% in children to 19.2% in adults ( $\geq$ 20 years). The prevalence was



**Figure 2.** Probability of masked hypertension (HT) plotted with 95% confidence interval as a function of age (**A**) and systolic (**B**) or diastolic (**C**) office blood pressure. For the reference population (n=3615), a continuous risk function is given. For Nigerians (n=293), mean values by fourths of the distributions of the explanatory variables are plotted superimposed on the continuous risk function in the reference population. Risk estimates were standardized to the average distribution in the reference population of sex (39% men), antihypertensive drug intake (12.3%), and age (mean: 54.7 y; **B** and **C**). *P* values denote the significance of the difference between Nigerians and the reference population.

independent of the technique of out-of-the office measurement, either ambulatory BP monitoring or self-measurement.<sup>26</sup> None of the studies included in this meta-analysis<sup>26</sup> was conducted among blacks living in Africa. Diaz et al27 recently studied the prevalence of masked hypertension in 1144 blacks living in the Jackson Mississippi metropolitan area. They averaged 2 BPs measured with a random zero sphygmomanometer as clinic pressure and averaged all measurements of the awake ambulatory BP as out-of-the-clinic BP. Among the 733 participants with normal clinic BP, the prevalence of masked hypertension was 34.4% overall and 25.4% and 39.1% among untreated and treated individuals, respectively. Although the prevalence among treated blacks was comparable with the African blacks enrolled in our study, the rate among the untreated participants was considerably lower. One plausible explanation is that in the Jacksonian Heart Study the prevalence of smoking was 13%,<sup>27</sup> whereas in our current study, it was only 1.7%. Cigarette smoking almost doubled the risk of masked hypertension in the Jackson Heart study (odds ratio, 1.93; 95% CI, 1.06-3.52)<sup>27</sup> as well as in the reference group of our present study (odds ratio 1.91; 95% CI, 1.48-2.47). The reported higher prevalence of masked hypertension among smokers as compared with nonsmokers have been reported in several previous cross-sectional studies.<sup>26-30</sup> Smoking acutely raises BP through sympathetic stimulation<sup>31</sup> and is associated with a sustained increase in BP at least when the latter is continuously recorded.32

Observing target organ damage in patients with optimal or normal office BP represents a major clue suggesting that masked hypertension might be present. Signs of target organ damage may include hypertensive retinopathy, left ventricular hypertrophy, diastolic or systolic left ventricular dysfunction, reduced glomerular filtration rate, microalbuminuria, or a history of cardiovascular disease. In previous publications,28,33 we identified various other risk factors associated with a high probability of masked hypertension diagnosed either by self-measurement of BP at home<sup>33</sup> or ambulatory BP monitoring.<sup>28</sup> In IDHOCO,33 participants with masked hypertension according to the 135/85-mmHg threshold, compared with participants with true optimal, normal, or high-normal BP, were more likely to be men (52.6% versus 37.1%), to smoke (28.7% versus 22.6%), to have diabetes mellitus (13.0% versus 5.2%) or a history of cardiovascular disease (14.6% versus 6.4%), and to be older (62.3 versus 53.4 years) and more obese (27.0 versus 24.6 kg/ m<sup>2</sup>). In the International Database on Ambulatory BP in relation to Cardiovascular Outcome,28 using a daytime systolic/diastolic BP of 135/85 mmHg, findings were similar. The main risk factors for masked hypertension were male sex, prehypertension on conventional BP measurement, diabetes mellitus, older age, higher body mass index, smoking, and excessive alcohol intake.28 Among 352 participants in the African Prospective Study on the Early Detection and Identification of Cardiovascular Disease and Hypertension (African-PREDICT),<sup>7</sup> aged 20 to 30 years, the prevalence of masked hypertension was 18%. Participants with masked hypertension (68% men) had higher clinic BP and higher levels of biomarkers reflecting adiposity, dyslipidemia, insulin resistance, and inflammation.7 In our current study, higher body mass index, obesity, and male sex were not significantly associated with masked hypertension in Nigerians at variance with the observations in the reference population. Selective recruitment and small sample size might explain the lack of associations with these risk factors in Nigerians.

Our findings should be interpreted within the context of its potential limitations and strengths. First, the study was done in a low-resource setting without substantial funding. Therefore, it involved a relatively small number of black participants. They were living in an urban area and so our results may not be readily extrapolated to other, in particular rural, areas of Nigeria. The population of Abuja, however, largely reflects the ethnic diversity of the whole nation as Nigerians of diverse ethnic origins converge to the growing capital city in search of opportunities for employment and business. Furthermore, Abuja being a growing metropolitan area also offers a rare opportunity to study the epidemiological transition in Africa, which is largely attributable to increasing urbanization. Moreover, our study has external validity as the determinants of masked hypertension in Abuja was comparable with that of a large reference sample. Nevertheless, our study in Nigeria should not be considered as being representative for the whole sub-Saharan continent.

The clinical implications of our study are potentially important. One may extrapolate the finding of a 9.0% prevalence of masked hypertension among the untreated Nigerians to ≈50 million Nigerians in the same age bracket adjudged to be normotensive by clinic measurement.<sup>6,34</sup> This translates to ≈4.5 million Nigerians living under the burden of undetected hypertension. Furthermore, the abysmally low level of control of hypertension reported according to some observational studies across different regions in Nigeria<sup>6,34</sup> and indeed also by other studies in various regions of sub-Saharan Africa<sup>35</sup> may still be further reduced if one considers that nearly half of the patients reported to have controlled hypertension by conventional clinic pressure evaluation may have uncontrolled masked hypertension. Masked hypertension in both treated and untreated individuals is by no means an innocuous state. Our group earlier evaluated the prognostic significance of masked hypertension in a 6458 participants from 5 populations enrolled in the IDHOCO.<sup>11</sup> After a median follow up of 8.3 years, 714 fatal plus nonfatal cardiovascular events occurred. Among untreated subjects, the cardiovascular risk among those who had masked hypertension was 55% higher (hazard ratio, 1.55; 95% CI, 1.12-2.14; P=0.008) when compared with truly normotensive subjects. Among treated patients with masked hypertension (low office and high home pressure), the risk was 76% higher (hazard ratio, 1.76; 95% CI, 1.23-2.53; P=0.002) when compared with controlled treated patients (low office and low home pressure).

The feasibility of introduction of out-of-office BP measurement as a routine screening procedure is still subject of intense debate in more developed economies. With poor economy, poor health infrastructure and near absence of health insurance, the situation is even more forlorn in most countries in sub-Saharan Africa. Findings from our study proved that home BP measurement can be used successfully in developing countries to diagnose masked hypertension. The determinants identified in the Nigerian population compare favorably with those in the reference population as well as the black population where ambulatory BP was used for out-of-office BP evaluation.<sup>27</sup> Many validated monitors for self-measurement of BP are affordable and can be incorporated into daily clinical use. Although it is unfeasible to screen the entire population, high-risk individuals, for example, those with clinic BP in the prehypertensive range, or those aged >40 years, or having comorbidities, such as diabetes mellitus, might be prioritized for screening for masked hypertension. Furthermore, if self-monitoring of the home BP is encouraged among hypertensive patients on treatment, it will not only help to identify individuals with masked uncontrolled hypertension but will also increase adherence with prescribed drugs.<sup>36</sup>

## **Perspectives**

With the current concern over the increasing burden of cardiovascular diseases in sub-Saharan Africa, our findings set the stage for future investigations into the contribution of masked hypertension to this burden. The current state of knowledge indicates that the prevalence of left ventricular remodeling or hypertrophy is not only higher<sup>37</sup> but also has more deleterious effects<sup>38</sup> among blacks. Although it is widely accepted that hypertension increases the risk of left ventricular hypertrophy,37 a substantial number of black people have increased left ventricular mass in the presence of a normal clinic pressure. A longitudinal study of black Africans with a baseline evaluation for masked hypertension will help to elucidate the contribution of masked hypertension to the development of the various spectra of left ventricular dysfunction and heart failure.37,38 In addition, since the existing evidence suggests that masked hypertension is more common in untreated normotensive diabetic patients as compared with normotensive nondiabetic population,<sup>39</sup> masked hypertension should be studied among African diabetic patients. The rationale is that number of adults with diabetes mellitus in the world is rising from 135 million in 1995 to 300 million in the year 2025.40 The major part of this numeric increase is occurring in developing countries, so that by 2025 >75% of patients with diabetes mellitus will reside in developing countries, as compared with 62% in 1995.40

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## Disclosures

None.

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## **Novelty and Significance**

## What Is New?

 This study examined for the first time the prevalence and determinants of masked hypertension (MH; office blood pressure <140/90 mm Hg and home blood pressure ≥135/85 mm Hg) in 293 blacks born and living in sub-Saharan Africa and compared the findings with a large reference population comprising 1762 Japanese and 1853 whites.

#### What Is Relevant?

- In the reference population, the prevalence of MH was 14.6% overall and 11.1% and 39.6% in untreated and treated participants, respectively.
- Among Nigerians, the prevalence standardized to the sex and age distribution in the reference population was similar amounting to 14.4%, 8.6%, and 34.6%, respectively.

 Older age as well as higher systolic and diastolic blood pressure on clinic measurement are the major risk factors for MH among Nigerians as well as the reference population.

#### Summary

MH is as common in Nigeria as other ethnic groups and shares the same risk factors. Our study highlights that a significant proportion of true hypertensive subjects remains undetected based on office blood pressure measurement. It therefore underscores the necessity to search for MH not only in patients on antihypertensive drug treatment but in the general population as well, particularly in the developing world, where cardiovascular disease instead of malnutrition and infection has become the main driver of mortality.