PREVALENCE, DETECTION, MANAGEMENT, AND CONTROL OF HYPERTENSION IN GHANAIAN CIVIL SERVANTS

Juliet Addo, MBChB, PhD; Liam Smeeth, MRCGP, PhD; David A. Leon, PhD

Objectives: The goal of this study was to determine the prevalence of hypertension and establish the levels of detection, treatment, and control among urban civil servants in Ghana.

Methods: A cross-sectional study was conducted on 1015 urban civil servants aged ≥25 years from seven randomly selected central government ministries in Accra, Ghana. Hypertension was diagnosed when the mean of a second and third blood pressure reading was ≥140/90 mm Hg or participants reported that they used antihypertensive medication.

Results: The age-adjusted (world standard population) prevalence of hypertension was 27.4% (95% CI 24.7%–30.1%). The prevalence of hypertension increased with age. The proportion of hypertensive participants with severe hypertension (blood pressure ≥180/110 mm Hg) was 19.2%. Among the 307 participants with hypertension, 54.1% had been previously detected, 31.3% were on treatment, and 12.7% had their blood pressure controlled (<140/90 mm Hg). Female sex was independently associated with higher detection and treatment of hypertension and better control. Hypertension was positively associated with age and body mass index and negatively associated with physical activity.

Conclusions: The high prevalence of hypertension in this population with considerable underdiagnosis and low levels of treatment and control is of great concern. It is important to introduce health education measures that will promote prevention and early detection of hypertension and encourage better compliance to treatment. The reasons for inadequate control must be investigated to enable implementation of appropriate measures to improve control and reduce the risk of developing complications. There is a need to encourage healthier lifestyles with emphasis on preventing obesity and increasing level of activity. (*Ethn Dis*. 2008;18:505–511)

Key Words: Hypertension, Detection, Treatment, Control, Ghana

From the Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, United Kingdom (JA, LS, DAL).

Address correspondence and reprint requests to: Juliet Addo; Department of Epidemiology and Population Health; London School of Hygiene and Tropical Medicine; Keppel Street; London WC 1E 7HT; 44-0-20-7299-4701; Juliet.addo@lshtm.ac.uk

INTRODUCTION

Hypertension is a common health problem worldwide and is estimated to contribute to 5.6% of the burden of disease in low- and middle-income countries.[1] In the year 2000 the total number of people with hypertension in economically developing countries was estimated to be 639 million.[2] Hypertension, which was considered to be nonexistent or extremely rare in most African societies, particularly in rural communities, is now emerging as a public health problem in sub-Saharan Africa.[3–5] Between 10 and 20 million people in sub-Saharan Africa may have hypertension, and treatment could prevent ≈250,000 deaths each year.[6] Recent studies from sub-Saharan Africa have shown high prevalence of hypertension with poor rates of detection, treatment, and control.[7–13] The absence of adequate treatment and control among those with hypertension invariably increases the risk of developing complications with an associated increase in morbidity and mortality.

Most population studies carried out in SSA have defined hypertension on the basis of blood pressure taken on one visit only, which can introduce error into the assessment of prevalence and inaccurately assess the need for treatment.[8,11,14–16] The purpose of this study was to determine the prevalence and distribution of clinically defined hypertension and establish the levels of detection, treatment, and control of hypertension. Civil servants in Accra work in a nonindustrial capacity, do not generally do manual labor, and are stably employed; they are a sentinel group who can be considered to have adopted a Westernized lifestyle at a relatively early stage in Ghana's development.

MATERIALS AND METHODS

A cross sectional study of hypertension was conducted among civil servants in Accra, the capital city of Ghana, from January through September 2006. The study involved seven ministries selected randomly from a list of all 26 civil service ministries in Accra. All workers ≥25 years of age in the central administration offices of these seven ministries were invited to participate. A recruitment system was set up whereby an administrative officer from each ministry or department invited all workers to participate in the study and coordinate follow-up visits. Pregnant women were excluded from the study. The ethics committees of the University of Ghana Medical School and the London School of Hygiene and Tropical Medicine approved the study protocol. Informed and written consent was obtained from each participant.

Trained interviewers collected information on demographic and health-related characteristics of each participant by using structured questionnaires. Measurements included blood pressure, height, weight, and waist circumference.

The purpose of this study was to determine the prevalence and distribution of clinically defined hypertension and establish the levels of detection, treatment, and control of hypertension.

Blood pressure was measured after participants had been sitting quietly for at least 10 minutes. A validated automated digital device, Omron M5I (Omron Matsuka Co. Ltd, Tokyo, Japan), was used.[17] Three measurements were taken at one-minute intervals on the right arm in a seated position, with arm supported at heart level and feet flat on the floor using an appropriate-size cuff. If systolic blood pressure (SBP) was >140 mm Hg or diastolic blood pressure (DBP) was >90 mm Hg in participants who were not taking antihypertensive medication, the measurements were repeated three weeks later. Hypertension was diagnosed if the mean of the second and third blood pressure measurements at both visits was ≥140/90 mm Hg or if participants reported taking antihypertensive medication.[18,19] Blood pressure was classified further as grade 1 (mild) if SBP was 140–159 mm Hg or DBP was 90–99 mm Hg, as grade 2 (moderate) if SBP was 160–179 mm Hg or DBP was 100–109 mm Hg, and as grade 3 (severe) if SBP was >180 mm Hg or DBP was >110 mm Hg.[20,21] Hypertensive participants were considered to have "detected" hypertension if they reported a diagnosis of hypertension by a health professional. Hypertension was considered to be "treated" if participants reported taking a recognized antihypertensive medication and was considered to be "controlled" if they took medication and had blood pressure <140/90 mm Hg.

Anthropometric measurements were taken while participants were wearing light clothing and no shoes. Weight was measured by using a professional Seca floor scale (Vogel and Halke, Hamburg, Germany) to the nearest .1 kg. Standing height was measured with a Seca stadiometer to the nearest millimeter while the participant was standing erect with back straight, heels together, and toes slightly apart at a 60° angle. Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. BMI was divided into World Health Organization categories: normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30.0 kg/m^2).[22]

The level of physical activity was determined from an evaluation of job-related physical activity and walking and cycling to work over the preceding 12 months. Physical activity was classified as light, moderate, or intense, according to the time spent walking or cycling to work and the pace and intensity of job-related activities. Smoking status was determined by self-report and classified as nonsmoker, former smoker (no smoking in the past year), or current smoker. Alcohol intake was assessed by self-report and classified as nondrinker, former drinker (no alcohol in the past year), and current drinker. Current drinkers were further classified on the basis of the number of days in a week they drank alcohol. Participants were classified into one of four job grades according to civil service categories: directors (senior administrators and managers), professional workers (professional staff and executive officers), clerical workers (secretarial and records staff), and unskilled workers.

All data forms were entered in Excel (Microsoft Corp, Redmond, Wash) and were checked for range and internal consistency. Data were analyzed with Stata release 9 (Stata Corp, College Station, Texas). Statistical tests included the χ^2 test for comparison of proportions and the Student *t* test for normally distributed data. Odds ratios and 95% confidence intervals were used to describe associations between hypertension and selected factors of interest in univariate logistic models. Multivariate logistic regression models were performed to examine the associations between hypertension and variables of interest, adjusting for potentially confounding variables. These were estimated by a series of models with hypertension as the outcome variable and other variables of interest as explanatory variables. All models were age-adjusted. Tests for trend were determined where appropriate on the basis of regression analysis with the relevant factor entered as a continuous variable. Prevalence of hypertension was standardized to the World Health Organization world standard population.[23]

RESULTS

A total of 1015 of 1227 eligible civil servants participated in the study (82.7%). Participation did not differ across ministries and departments. The participation rate was 84.4% in women and 81.7% in men. The main reason for nonparticipation was absence from work during survey. Participants were aged 25–68 years. All employment grades were reasonably well represented. Half of the women were clerical workers, which is the pattern generally observed in civil service. More than half of participants were overweight or obese, and 4.1% were current smokers. (Table 1)

Table 2 shows the median (interquartile range) systolic and diastolic blood pressures in males and females in the study population. We calculated median blood pressures instead of means because analysis of medians is associated with less bias when some persons in the study sample are likely to be taking antihypertensive medica-

Table 1. Characteristics of 1015 civil servants in Accra, Ghana, 2006

Variable	Men (*n*=615)	Women (*n*=400)	Total (*N*=1015)	*P* value
Mean age ± SD (years)	44.6±9.9	43.0±10.4	44.0±10.1	.01
Mean BMI (kg/m^2)	24.7±4.3	28.2±5.8	26.1±5.8	<.001
BMI distribution (%)				
BMI < 18.5 kg/m^2	4.1	3.5	3.8	
BMI 18.5–24.9 kg/m^2	52.0	27.0	42.2	<.001
BMI 25.0–29.9 kg/m^2	34.0	34.0	34.0	
BMI ≥ 30.0 kg/m^2	9.9	35.5	20.0	
Physical activity (%)				
Light	57.9	66.0	61.1	
Moderate	34.8	30.0	32.9	.01
Intense	7.3	4.0	6.0	
Employment grade (%)				
Unskilled	26.7	11.8	20.8	
Clerical	17.1	50.0	30.1	<.001
Professional	41.1	31.8	37.4	
Director	15.1	6.5	11.7	
Smoking (%)				
Nonsmoker	85.0	98.8	90.4	
Current smoker	6.6	.25	4.1	<.001
Former smoker	7.8	.5	4.9	
Alcohol consumption (%)				
Nondrinker	37.2	52.5	43.2	
Current drinker	55.3	41.0	49.6	<.001
Former drinker	6.8	5.2	6.2	

SD, standard deviation; BMI, body mass index.

tion.[24,25] Blood pressure in our participants increased with age in both sexes; DBP in women peaked at ages 45–54 and decreased slightly thereafter.

High blood pressure (>140/90 mm Hg) was present in 377 (37.1%) of participants on the first visit. By defining hypertension as the average of readings taken on subsequent visits, the unadjusted prevalence of hypertension was 30.3% (age-adjusted prevalence 27.4%) (Table 3).

Among the 307 participants diagnosed with hypertension, 54.1% had been previously detected, 31.3% were on antihypertensive treatment, and 12.7% had blood pressure adequately controlled. Among the 166 participants who had been previously detected, 57.2% were on treatment and 23.5% had blood pressure adequately controlled. More women than men had been previously detected, were on treatment, and had blood pressure controlled. Among the 307 participants with hypertension, 42.7% had mild hypertension, 25.4% had moderate hypertension, and 19.2% had severe hypertension. More men (21.0%) than women (16.1%) had severe hypertension.

In multivariate logistic regression analysis (Table 4), hypertension was significantly associated with age, male sex, and obesity. The level of physical activity was generally inversely associated with hypertension, although the trend did not reach significance in all models. There was no significant association observed between alcohol consumption and the risk of hypertension.

DISCUSSION

This study in an urban working population in Ghana shows a high prevalence of hypertension. The overall participation rate in the study of 82.7% was high, and there were no significant differences between the participants and the nonparticipants interviewed, making our sample representative of all civil servants in Accra. The prevalence of hypertension increased with age in both males and females. A high proportion of participants with hypertension had blood pressure ≥ 180/110 mm Hg (19.2%). Detection, treatment and control of hypertension in this population was rather poor with a little over half of those with hypertension having been previously detected and just about one third on pharmacological treatment. The level of hypertension control was extremely low. Control was low even among those who had been previously detected and were on treatment. Females were more likely to have been detected as having hypertension, to be on treatment and to have blood pressure controlled compared to males. Although the survey period extended between January and September, it is unlikely that seasonal variations may

Table 2. Blood pressure by age and sex among 1015 civil servants in Accra, Ghana, 2006

	Men	Women	All participants
Blood pressure (mm Hg)	Median blood pressure (interquartile range)	Median blood pressure (interquartile range)	Median blood pressure (interquartile range)
Systolic			
25–34 years	125.0 (116.5–133.0)	113.5 (106.0–121.0)	119.0 (111.0–129.5)
35–44 years	127.5 (121.3–135.5)	117.5 (109.0–126.5)	125.0 (116.5–133.5)
45 –54 years	135.5 (125.0–150.5)	130.8 (117.8–146.0)	134.0 (122.0–149.0)
≥55 years	140.3 (130.3–165.8)	131.8 (120.0–149.0)	137.0 (126.0–154.8)
All ages	131.5 (122.0–144.0)	121.5 (111.3–135.0)	128.5 (117.0–140.5)
Diastolic			
25–34 years	72.5 (67.5–78.5)	69.0 (63.5–75.5)	71.3 (65.0–77.3)
35–44 years	77.5 (71.5–86.0)	76.0 (69.0–82.0)	76.5 (70.0–85.0)
45 –54 years	84.5 (76.0–94.0)	83.5 (76.0–91.8)	84.0 (76.0–93.5)
≥55 years	85.0 (77.3–97.0)	79.8 (72.5–89.8)	84.5 (74.5–94.3)
All ages	80.0 (72.5–89.5)	77.0 (69.0–85.3)	79.0 (71.0–87.5)

have had an impact on the findings due to an absence of extreme variations in temperature between seasons in Ghana.

The present study is one of the few population studies in sub-Saharan Africa that has based the definition of hypertension on multiple blood pressure readings taken on more than one visit. Taking three blood pressure readings on two visits is more accurate in estimating the true prevalence of hypertension in populations.[26] The age-standardized prevalence of hypertension of 27.4% observed in this sample is comparable to prevalences reported from other studies in sub-Saharan Africa and from North America.[7,9,10,26–32] Analysis of worldwide data estimated that 26.4% of the world's population had hypertension in 2000.[2] The high prevalence of hypertension in sub-Saharan Africa, particularly in urban areas, may reflect the adoption of Western lifestyles with industrialization and urbanization, with resultant shifts from traditional diets and activity patterns. The consumption of more processed foods that are high in fat and salt, and the tendency of decreased physical activity resulting in overweight and obesity, are likely contributing factors to the increased hypertension prevalence.

As would be expected, increasing age and increasing BMI were associated with an increased prevalence of hypertension, and our data suggested an inverse association between level of physical activity and hypertension. The prevalence of hypertension in Ghana is likely to increase with industrialization, economic development, and associated transition in nutrition. Improvements in nutrition and sanitation and increasing access to health interventions and consequent decline in mortality and increase in the life expectancy at birth, are likely to be associated with an increase in the incidence of hypertension. The burden of hypertension would be even greater in the absence of measures to control excess weight gain and to encourage physical activity.

Studies from sub-Saharan Africa have consistently shown low levels of detection, treatment, and control of

Table 3. Prevalence, detection, treatment, and control of hypertension by sex and age group among 1015 civil servants in Accra, Ghana, 2006

Variable	Unadjusted prevalence, % (95% CI)	Awareness, % (n_1/n)*	Treatment, % (n_1/n)*	Control, % (n_1/n)*
Sex				
Men (n=615)	31.7 (28.0–35.4)	43.1 (84/195)	22.6 (44/195)	4.1 (8/195)
Women (n=400)	28.0 (23.6–32.4)	73.2 (82/112)	46.4 (52/112)	27.7 (31/112)
All participants (N=1015)	30.3 (27.4–33.0)	54.1 (166/307)	31.3 (96/307)	12.7 (39/307)
Age group (years)				
25–34 (n=232)	5.6 (2.6–8.6)	30.8 (4/13)	23.1 (3/13)	15.4 (2/13)
35–44 (n=249)	20.1 (15.1–25.1)	48.0 (24/50)	26.0 (13/50)	16.0 (8/50)
45–54 (n=358)	43.9 (38.8–49.0)	56.7 (89/157)	33.8 (53/157)	14.0 (22/157)
≥55 (n=176)	49.4 (42.0–56.8)	56.3 (49/87)	31.1 (27/87)	8.1 (7/87)

CI, confidence interval.

* The denominator (n) is the total number of participants in that subgroup with hypertension, and the numerator (n_1) is the number of those participants who were aware of their hypertension, had been treated with antihypertensive medication, or had their blood pressure controlled to <140/90 mm Hg.

Table 4. Odds of hypertension associated with selected variables among 1015 civil servants in Accra, Ghana, 2006

Variable	Prevalence of hypertension % (*n*/*N*)	Adjusted OR (95% CI)*	Adjusted OR (95% CI)†	Adjusted OR (95% CI)‡
Sex				
Men	31.7 (195/615)	1.00	1.00	1.00
Women	28.0 (112/400)	.92 (.68–1.24)	.69 (.49–.97)	.71 (.50–.99)
Age group (years)				
<35	5.6 (13/232)	1.00	1.00	1.00
35–44	20.1 (50/249)	4.20 (2.22–7.97)	3.73 (1.95–7.13)	3.79 (2.02–7.40)
45–54	43.9 (157/358)	13.09 (7.20–23.79)	11.27 (6.17–20.61)	11.28 (6.38–21.48)
≥55	49.4 (87/176)	16.31 (8.66–30.73)	14.94 (7.89–28.26)	15.02 (8.24–29.76)
P value for trend		<.001		
BMI (kg/m^2)				
Normal (18.5–24.9)	23.6 (101/428)	1.00		1.00
Underweight (<18.5)	15.4 (6/39)	.53 (.21–1.36)		.47 (.18–1.23)
Overweight (25.0–29.9)	32.5 (112/345)	1.42 (1.01–2.02)	—	1.24 (.74–1.83)
Obese (≥30.0)	43.4 (88/203)	2.36 (1.55–3.40)		1.67 (.79–2.61)
P value for trend		<.001		
Physical activity				
Light activity	33.4 (207/620)	1.00	1.00	1.00
Moderate activity	25.5 (85/334)	.68 (.49–.94)	.73 (.53–1.01)	.71 (.51–.99)
Intense activity	24.6 (15/61)	.57 (.30–1.08)	.65 (.34–1.25)	.64 (.33–1.23)
P value for trend		.01		
Alcohol use				
Never	28.2 (131/464)	1.00	1.00	1.00
Stopped	33.3 (21/63)	.91 (.50–1.66)	.88 (.48–1.62)	.87 (.47–1.61)
Once/week	30.4 (95/313)	.94 (.67–1.33)	.85 (.60–1.20)	.83 (.58–1.17)
2–3 times/week	30.3 (30/99)	.83 (.50–1.39)	.80 (.48–1.35)	.83 (.49–1.40)
≥4 times/week	39.5 (30/76)	1.45 (.83–2.54)	1.49 (.85–2.62)	1.57 (.89–2.78)

OR, odds ratio; CI, confidence interval; BMI, body mass index.
* Adjusted for age and sex.
† Adjusted for age, sex, and BMI.
‡ Adjusted for age, sex, BMI and the other variables in the table.

hypertension, and some reported levels lower than those in this study.[7,9–12,26,27] The levels of detection, treatment, and control of hypertension reported from sub-Saharan Africa are generally lower than that from high-income countries.[30,33] This finding could be due to less access to medical care in sub-Saharan Africa and high costs of antihypertensive medication. The poor levels of detection, treatment, and control may be due to financial constraints but may also be due to lack of awareness of the need to treat a condition with basically no symptoms. The level of detection, treatment, and control reported for women has been higher than for men in most studies.[9,26,30,34–36] A possible explanation could be that women are more likely to have blood pressure measured during pregnancy, have hypertension detected if present, and to accept treatment or lifestyle changes more readily.

Even though a higher proportion of hypertensive participants aged ≥55 years were more likely to be detected and on treatment, the proportion controlled was lower than among the other age groups. This finding is similar to a report from another Ghanaian study[7] and could be because older people are more likely to be screened for hypertension when they present to a health facility.

The study had some limitations. The sample was not nationally representative, and the findings can therefore not be generalized to the entire Ghanaian population. The study participants were, however, drawn from the full range of job grades and as such were representative of a working population in urban Ghana. We also did not evaluate salt intake quantitatively, which could have explained the high prevalence of hypertension.

This study provides useful information on hypertension in an urban working population in Ghana. The prevalence of hypertension is high among this population, and levels of treatment and control are low. Introducing screening programs to detect hypertension and other cardiovascular risk factors may improve hypertension detection, treatment, and control in civil servants in Ghana.

Research into the low levels of treatment and control in this population is needed to identify ways of improving hypertension rates. Several reasons exist and include individual and system barriers. Those with hypertension may

The age-standardized prevalence of hypertension of 27.4% observed in this sample is comparable to prevalences reported from other studies in sub-Saharan Africa and from North America.[7,9,10,26–32]

require assistance from their employers for the cost of treatment. It is necessary to develop guidelines for hypertension management in Ghana, targeted at all health professionals in both public and private sectors. These guidelines should reflect realistic objectives that can be applied widely in the Ghanaian context and must encourage blood pressure measurements in all adults visiting a health facility even with unrelated disorders. There is an urgent need to introduce health promotion measures aimed at increasing the awareness of hypertension and its complications, and encouraging healthier lifestyles. It is evident from this study that, in addition to applying blood pressure lowering interventions to the entire population, certain populations should be targeted for more intense interventions: the overweight or obese, those with jobs involving minimal physical activity, and older-aged participants. The entire population must be encouraged to adopt healthier lifestyles and diets, decreasing salt intake and increasing the consumption of fruits and vegetables. Civil servants and indeed the entire population, must be provided with opportunities to increase physical activity.

ACKNOWLEDGMENTS

We are grateful to the management of the Office of the Head of Civil Service of Ghana who approved the work and were supportive. We also thank all the participants. This research is partly funded by the Commonwealth Scholarship Commission. The work was supported by the Wingate Foundation (UK). LS is supported by a Senior Research Fellowship in Clinical Science from the Wellcome Trust. The sponsors had no role in study design, data collection, analysis, interpretation, or writing of the report.

REFERENCES

1. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *Lancet*. 2006;367:1747–1757.
2. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. *Lancet*. 2005;365:217–223.
3. Shaper AG. Cardiovascular disease in the tropics. 3. Blood pressure and hypertension. *Br Med J*. 1972;3:805–807.
4. Pobee JO, Larbi EB, Belcher DW, Wurapa FK, Dodu SR. Blood pressure distribution in a rural Ghanaian population. *Trans R Soc Trop Med Hyg*. 1977;71:66–72.
5. van der Sande MA, Milligan PJ, Nyan OA, et al. Blood pressure patterns and cardiovascular risk factors in rural and urban Gambian communities. *J Hum Hypertens*. 2000;14:489–496.
6. Cooper RS, Rotimi CN, Kaufman JS, Muna WF, Mensah GA. Hypertension treatment and control in sub-Saharan Africa: the epidemiological basis for policy. *BMJ*. 1998;316:614–617.
7. Agyemang C, Bruijnzeels MA, Owusu-Dabo E. Factors associated with hypertension awareness, treatment, and control in Ghana, West Africa. *J Hum Hypertens*. 2006;20:67–71.
8. Amoah AG. Hypertension in Ghana: a cross-sectional community prevalence study in greater Accra. *Ethn Dis*. 2003;13:310–315.
9. Bovet P, Ross AG, Gervasoni JP, et al. Distribution of blood pressure, body mass index and smoking habits in the urban population of Dar es Salaam, Tanzania, and associations with socioeconomic status. *Int J Epidemiol*. 2002;31:240–247.
10. Cappuccio FP, Micah FB, Emmett L, et al. Prevalence, detection, management, and control of hypertension in Ashanti, West Africa. *Hypertension*. 2004;43:1017–1022.
11. Edwards R, Unwin N, Mugusi F, et al. Hypertension prevalence and care in an urban and rural area of Tanzania. *J Hypertens*. 2000;18:145–152.
12. Kamadjeu RM, Edwards R, Atanga JS, Unwin N, Kiawi EC, Mbanya JC. Prevalence, awareness and management of hypertension in Cameroon: findings of the 2003 Cameroon Burden of Diabetes Baseline Survey. *J Hum Hypertens*. 2006;20:91–92.
13. Duda RB, Kim MP, Darko R, et al. Results of the Women's Health Study of Accra: assessment of blood pressure in urban women. *Int J Cardiol*. 2007;117:115–122.
14. Ekpo EB, Udofia O, Eshiet NF, Andy JJ. Demographic, life style and anthropometric correlates of blood pressure of Nigerian urban civil servants, factory and plantation workers. *J Hum Hypertens*. 1992;6:275–280.
15. Olatunbosun ST, Kaufman JS, Cooper RS, Bella AF. Hypertension in a Black population: prevalence and biosocial determinants of high blood pressure in a group of urban Nigerians. *J Hum Hypertens*. 2000;14:249–257.
16. Swai AB, McLarty DG, Kitange HM, et al. Low prevalence of risk factors for coronary heart disease in rural Tanzania. *Int J Epidemiol*. 1993;22:651–659.
17. El Assaad MA, Topouchian JA, Asmar RG. Evaluation of two devices for self-measurement of blood pressure according to the international protocol: the Omron M5-I and the Omron 705IT. *Blood Press Monit*. 2003;8:127–133.
18. Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA*. 2003;289:2560–2572.
19. World Health Organization Guidelines Subcommittee. 1999 World Health Organization-International Society of Hypertension guidelines for the management of hypertension. *J Hypertens*. 1999;17:151–183.
20. Whitworth JA, World Health Organization/International Society of Hypertension Writing Group. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. *J Hypertens*. 2003;21:1983–1992.
21. Williams B, Poulter NR, Brown MJ, et al. British Hypertension Society guidelines for hypertension management 2004 (BHS-IV): summary. *BMJ*. 2004;328:634–640.
22. World Health Organization. Physical status: the use and interpretation of anthropometry. Geneva: WHO Technical Report Series No. 854; 1995.
23. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. Global Programme on Evidence for Health Policy Discussion Paper Series: no. 31. Geneva: World Health Organization; 2000.
24. White IR, Chaturvedi N, McKeigue PM. Median analysis of blood pressure for a sample including treated hypertensives. *Stat Med*. 1994;13:1635–1641.
25. White IR, Koupilova I, Carpenter J. The use of regression models for medians when observed outcomes may be modified by interventions. *Stat Med*. 2003;22:1083–1096.

26. Bovet P, Gervasoni JP, Ross AG, et al. Assessing the prevalence of hypertension in populations: are we doing it right? *J Hypertens*. 2003;21:509–517.
27. Cooper RS, Amoah AG, Mensah GA. High blood pressure: the foundation for epidemic cardiovascular disease in African populations. *Ethn Dis*. 2003;13:S48–52.
28. Agyemang C. Rural and urban differences in blood pressure and hypertension in Ghana, West Africa. *Public Health*. 2006;120:525–533.
29. Cooper R, Rotimi C, Ataman S, et al. The prevalence of hypertension in seven populations of West African origin. *Am J Public Health*. 1997;87:160–168.
30. Wolf-Maier K, Cooper RS, Kramer H, et al. Hypertension treatment and control in five European countries, Canada, and the United States. *Hypertension*. 2004;43:10–17.
31. Agyemang C, Owusu-Dabo E. Prehypertension in the Ashanti region of Ghana, West Africa: an opportunity for early prevention of clinical hypertension. *Public Health*. 2008;122:19–24.
32. Burket BA. Blood pressure survey in two communities in the Volta region, Ghana, West Africa. *Ethn Dis*. 2006;16:292–294.
33. Whelton PK, He J, Muntner P. Prevalence, awareness, treatment and control of hypertension in North America, North Africa and Asia. *J Hum Hypertens*. 2004;18:545–551.
34. Fuentes R, Ilmaniemi N, Laurikainen E, Tuomilehto J, Nissinen A. Hypertension in developing economies: a review of population-based studies carried out from 1980 to 1998. *J Hypertens*. 2000;18:521–529.
35. Lang T, Pariente P, Salem G, Tap D. Social, professional conditions and arterial hypertension: an epidemiological study in Dakar, Senegal. *J Hypertens*. 1988;6:271–276.
36. Cruickshank JK, Mbanya JC, Wilks R, et al. Hypertension in four African-origin populations: current 'Rule of Halves,' quality of blood pressure control and attributable risk of cardiovascular disease. *J Hypertens*. 2001;19:41–46.

AUTHOR CONTRIBUTIONS

Design concept of study: Addo, Smeeth, Leon
Acquisition of data: Addo
Data analysis and interpretation: Addo, Smeeth, Leon
Manuscript draft: Addo, Smeeth, Leon
Statistical expertise: Addo, Smeeth
Acquisition of funding: Addo, Smeeth
Administrative, technical, or material assistance: Addo, Smeeth
Supervision: Smeeth, Leon