Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-001217
Article Type:	Research
Date Submitted by the Author:	01-Apr-2012
Complete List of Authors:	Dzudie, Anastase Kengne, Andre; South African Medical Research Council, National Collaborative Programme on Cardiovascular and metabolic Disease; The George Instute for Global Health, Muna, Walinjom Ba, Hamadou Menanga, Alain Kouam Kouam, Charles Abah, Joseph Monkam, Yves; General Hospital of Douala, Department of Internal Medicine Biholong, Christian; General Hospital of Douala, Department of Internal Medicine Mintom, Pierre Kamdem, Felicite; General Hospital of Douala, Department of Internal Medicine Djomou, Armel; General Hospital of Douala, Department of Internal Medicine Ndjebet, Jules; General Hospital of Douala, Department of Internal Medicine Ouambo, Cyrille Luma, Henry; General Hospital of Douala, Department of Internal Medicine Ngu, Kathleen Kingue, Samuel
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Cardiovascular medicine, Epidemiology
Keywords:	Hypertension < CARDIOLOGY, EPIDEMIOLOGY, PUBLIC HEALTH

Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Short title: Awareness, treatment and control of hypertension

Anastase Dzudie, MD, FESC(1); André Pascal Kengne, MD, PhD(2); Walinjom F.T. Muna, MD, PhD, FACC(3); Hamadou Ba, MD(1); Alain Menanga, MD (4); Charles Kouam Kouam, MD(5); Joseph Abah, MD(6); Yves Monkam, MD(1); Christian Biholong, MD(1); Pierre Mintom, MD(4); Félicité Kamdem, MD(1); Armel Djomou, MD(1); Jules Ndjebet, MD(1); Cyrille Ouambo, MD, PhD(1); Henri Luma, MD(1), Katleen Blackett Ngu, MD, FESC(6); Samuel Kingue, MD(6); On behalf of the CCS investigator group*.

(1) Department of Internal Medicine, Douala General Hospital and Buea Faculty of medicine, Cameroon

(2) NCRP or Cardiovascular and metabolic disease, South African Medical Research Council & University of Cape Town, Cape Town, South Africa

(3) Department of Internal Medicine, Faculty of Medicine and Biomedical Sciences, Yaounde, Cameroon

(4) Department of Internal Medicine, Yaounde General Hospital , Cameroon

(5) Department of Internal Medicine, Bafoussam Regional Hospital , Cameroon

(6) Department of Internal Medicine, Bamenda Military Hospital , North West Region, Cameroon

Correspondence to: Dr Anastase Dzudie, MD; FESC. Douala General Hospital; PO Box 4856, Douala General Hospital, Douala – Cameroon, Tel: +(237)79617981; Fax: +(237)33370146; email: aitdzudie@yahoo.com

Tables #5; Figures #2.

Word count: Abstract (265); Main text excluding reference, figure legend and references (3720)

* Members list in the appendix section

Abstract

Objectives. Hypertension has been established as a major public health problem in Africa, but its specific contributions to disease burden are still incompletely understood. We quantified the burden and determinants of hypertension, detection, treatment and control rates among adults in major cities in Cameroon.

Design. Cross-sectional study

Settings. Community-based multicenter study in major cities in Cameroon

Participants. Participants were self-selected urban dwellers from the Center, Littoral, North-West and West Regions, who attended on May 17th 2011 a screening campaign advertised through mass media.

Primary and secondary outcomes measures. Hypertension defined as systolic (and/or diastolic) blood pressure ≥ 140 (90) mmHg, or ongoing blood pressure (BP) lowering medications.

Results. In all, 2120 participants (1003 women) were included. Among them, 1007 (prevalence rate 47.5%) had hypertension, including 319 (awareness rate 31.7%) who were aware of their status. The prevalence of hypertension increased with age overall and by sex and region. Among aware hypertensive subjects, 191 (treatment rate 59.9%) were on regular BP lowering medication, and among those treated, 47 (controlled rate 24.6%) were at target BP levels (i.e. systolic (and diastolic) BP <140 (90) mmHg). In multivariable logistic regressions analysis, male gender, advanced age, parental history of hypertension, diabetes mellitus, elevated waist, and elevated body mass index (BMI) were the significant predictors of hypertension. Likewise, male gender, high BMI and physical inactivity were associated with poor control.

Conclusions. High prevalence of hypertension with low awareness, treatment and control were found in this urban population; these findings are significant and alarming with

consideration to the various improvements in the access to healthcare and the continuing efforts to educate communities over the past decades.

Word count - 265

Key Words: Hypertension, prevalence, awareness, treatment, control, Cameroon, Africa

Article summary

Article focus

- This article quantified the burden and determinants of hypertension, detection, treatment and control rates among adults in major cities in Cameroon, central Africa

Key messages

- The prevalence of hypertension was very high in this population, coupled with low detection, treatment and control rates.
- Age, gender and excess weight were the main drivers of the high prevalence, while the coincidence of classical cardiovascular risk factors was associated with poor control.

Strengths and limitations of this study

- Major strengths of this study include the large sample, the multicenter nature, the rigorous data collection on a range of determinants and provision of standardized prevalence figures.
- Limitations include the selection of participants, and hypertension diagnosis based on blood pressure measurement during a single encounter.

Introduction

Hypertension has been established as a major public health problem worldwide.[1] Several published studies suggest that hypertension is the commonest modifiable risk factor for stroke, congestive heart failure and kidney failure[2-5] in the sub-Saharan African (SSA) region. It is a major contributor to overall mortality risk in adults in the region.[6] Hypertension also seems to be more common in urban than rural population[7] of the SSA region.

Specific risks associated with various blood pressure (BP) readings have largely been established for populations in many parts of the developed world but this is not the case for countries of the developing world including the SSA region. There is considerable evidence that long-term BP lowering to what is considered either normal or optimal levels results in several significant and important health benefits.[8] When established norms for ideal or optimal BP are applied to SSA populations, it becomes very evident that the vast majority of eligible patients do not enjoy the benefits of BP lowering therapies, either because of under-diagnosis or the many other barriers to BP lowering medications prescription, access and compliance in this setting.[1 2] As a case in point, a survey in Cameroon about eight years ago found that only 23% of all individuals with hypertension at the community level were aware of their status.[9] Moreover, only 46% of those aware (11% of all those with hypertension) were on treatment, among whom only 19% (2% of all those with hypertension) achieved expected target BP levels.[9]

There is also evidence that SSA is undergoing very rapid transitions characterized by increasing urbanization, including the adoption of unhealthy lifestyles.[10 11] These transitions are paralleled by changes in the profile of chronic disease risk factors including

blood pressure.[7] Recently there has been increasing awareness of the threat that the looming chronic diseases pose to the health of the population in the Region at different levels.[12] This increasing awareness has catalyzed initiatives aimed at improving access to detection and care of chronic diseases including hypertension[13] in many countries of the region. The pace of the above mutations suggests that, data on the burden of hypertension, must be updated regularly, in order to provide the reliability needed in drawing-up health service and policy solutions.

The aim of this study was to assess the prevalence and determinants of hypertension, and including the detection, treatment and control rates, as well as the variability by region and gender in four major cities of Cameroon.

Material and methods

Study population and settings

This was a cross-sectional population-based study conducted in the regional capitals of the Centre (Yaounde), Littoral (Douala), North-West (Bamenda) and West (Bafoussam) administrative regions (out of a total of ten) of Cameroon. According to the Cameroon National Institute of Statistics,[14] the four participating regions had a total population of 9.98 million in 2010 (51% of the country's total population: 19.41 millions). In this same year, 57.5% of the national population was aged 15 years and above, and about 52% resided in what was defined as an urban area.[14] During three consecutive weeks leading to the specified day of the survey, daily announcements were made through radio and television, inviting all interested adults (or individuals aged 15 years and above) to report to any of the screening sites in participating cities. Such explanation included advice on the importance of measuring and knowing one's blood pressure under the slogan "I know my blood pressure. And you?". Announcements were also made in churches and market places. The study

protocol was approved by the Cameroon National Ethics Committee and signed informed consent obtained from each participant.

Data collection

The screening was conducted by trained medical personnel, simultaneously in the four cities on the specified date of May 17th 2011. All participants were subjected to a face-to-face interview during which data were collected (using a standardized questionnaire) on demographics, smoking habits and alcohol consumption, physical activity, parental history of hypertension, personal medical history (where the diagnosis was made by a physician) of hypertension including drug treatment, diabetes mellitus, gout and dyslipidemia. The physical examination included blood pressure (BP) and anthropometric measurements. BP (systolic and diastolic) was measured using a standardized protocol with the subject in a seated position, and after at least 10 minutes rest. Subjects with evidence of recent (less than 30 minutes) alcohol intake or smoking were invited to a 30 minutes rest before BP measurement. BP measurements were performed on the right arm using automated sphygmomanometers (OMRON M3 HEM-7200-E Omron Matsusaka Co Ltd, Japan). Special attention was given to the use of appropriate cuff sizes (13×23 cm or 16×30 cm). Weight (to the nearest 0.5 kg) was measured with the use of an automated scale. Subjects were permitted to keep on light clothing. Height (in meters to the nearest 0.5cm) was measured using a wooden platform and a height rule. Body mass index (BMI in kg/m^2) was calculated as weight (kg)/[height (m) X height (m)]. Waist circumference was measured midway between the iliac crest and the lower rib margin and the hip circumference was measured at the intertrochanteric level. Waist-to-hip ratio (WHR) was calculated as waist (cm)/Hip (cm) circumferences.

Definitions

Respondents were classified as hypertensive if they had a systolic (and/or diastolic) BP of 140 (90) mmHg or higher, or if they were on blood pressure lowering medications over the last 15 consecutive days. Participants with hypertension were considered to be aware of their status if they answered 'yes' to the question 'have you ever been told by a doctor or health professional that you had hypertension?'. Treatment of high BP was defined by the use of BP lowering medications. Hypertension was considered to be controlled among treated individuals when systolic (and diastolic) SBP was < 140 (90) mmHg or <130 (80) mmHg in individuals with diabetes. Waist circumference >94 cm in men or 80 cm in women was considered to be high. Excessive alcohol consumption was based on intake of either more than three (two for women) standard glasses of wine per day or more than ten (five for women) local beers (1 local beer contains 28 g of alcohol) per week. Participants who smoked at least one cigarette per day or who had stopped smoking within the last three years were classified as current smokers, and those who had stopped smoking for more than three years were classified as former smokers. Regular non-work related physical activity was considered in participants reporting at least 30 min of intense physical activity, once a week or more.

Handling of participants with high blood pressure

Participants with hypertension (known or screened-detected) received on-site medical counseling and were referred back to their attending physician (known cases), or to specialists within the vicinity of the participant's residential area for workup and long-term management. Few participants with excessively high BP with or without suspected acute target organ damage were immediately referred to emergency departments for appropriate care.

Statistical analysis

Data analysis used the Statistical Package for Social Sciences (SSPS Inc, Chicago, IL) version 17.0 software. Results are summarized as count and percentages for qualitative variables and mean and standard deviation (SD) for quantitative variables. Age-adjusted prevalence was

calculated using the Cameroon National population's age structure in 2010 as standard population.[15] Direct standardization methods was applied.[16] Group comparisons used chi square tests and equivalents for qualitative variables and Student t-test, analysis of the variance (ANOVA) for quantitative variables. Logistic regressions analyses were used to investigate potential determinants of prevalent hypertension and control. A p-value<0.05 was used to characterize statistically significant results.

Results

The study population

Two thousand one hundred and twenty eligible participants reported for screening in the four regions including 649 (30.6%) in the Centre, 1167 (54.1%) in the Littoral and 304 (14.3%) in the West and North West regions. Their overall profile including gender and region is summarized in Table 1. Participants included 1003 women (47.3%). Compared with men, women had similar age (43 vs. 44 years, p=0.19), similar waist circumference (93 vs. 93 cm, p=0.80), and similar history of diabetes mellitus, dyslipidemia and gout (all p≥0.07, Table 1). They were likely to have higher body mass index, higher prevalence of parental history of hypertension, lower systolic and diastolic blood pressure, and were less likely to be either a smoker or alcohol drinker and physically active (all p≤0.001. Table 1). With a few exceptions, the above pattern was consistent within participating regions. However, the small numbers of recruits in some subgroups translated into non-significant men/women differences (Table 1). With the exception of smoking (p=0.07), differences were also apparent in the baseline profile across Regions (all p≤0.01 for differences across regions).

Blood pressure profile

Mean systolic and diastolic BP (SD) at the total population level (men vs. women) was 139 (25) vs. 134 (28) mmHg (p<0.001), and 83 (17) vs. 80 (17) mmHg (p=0.001). Mean systolic

BP steadily increased with increasing age in men and women and across participating regions. Diastolic BP also increased with increasing age, but only up to the fourth and fifth decade of age, after which the pressure stabilized. This was observed in men and women and across regions (Figure 1).

The distribution of participants by BP categories according to the 2003 ESH/ESC classification[17] by sex overall and by age groups is provided in Table 2. An optimal BP was observed in 21.6% of men and 29.6% of women. The prevalence of optimal or normal BP decreased with increasing age in men and women (all $p \leq 0.001$ for linear trend). Conversely, with the exception of grade 1 hypertension (both $p \geq 0.09$ for linearity) and high normal BP in women only ($p=0.13$), the prevalence of all other BP categories linearly increased with increasing age (all $p<0.001$ for linear trend, Table 2).

Prevalence of hypertension, and awareness and control rates

The prevalence of hypertension was 47.5% overall, and 50.1% and 44.6% in men and women respectively ($p<0.001$), Table 3. As expected, prevalence rate sharply increased with age down from 31.7% (men) and 20.2% (women) in the age group <35 years, up to 77.6% (men) and 75.2% (women) in the age group 55 years and above (Table 3). Awareness rate increased with increasing age in men and women (both $p<0.001$ for linear trend). Among participants with hypertension, 24.6% in men and 40.5% in women were aware of their condition, and those remaining were newly diagnosed. Of those aware of their hypertensive status, 57.9% in men and 61.3% in women were on BP lowering medications, similarly across age groups in men ($p=0.53$ for linear trend), and with a modest linearly increasing trend with age in women ($p=0.03$, Table 3). Among treated patients, 27.5% in men and 38.7% in women were at target BP levels [i.e. systolic (and diastolic) BP <140 (90) mmHg), and similarly across age strata (both $p \geq 0.06$ for linear trend). Control rate was about 10% lower when the target BP level of <130 (80) was applied to participants with diabetes (Table 3).

Predictors of hypertension and control among urban dwellers

In unadjusted logistic regressions analysis, male gender, increasing age, Region, parental history of hypertension, personal history of diabetes, gout, excessive alcohol consumption, high BMI and high waist circumference were associated with prevalent hypertension (Table 4). In multivariable adjusted models, history of gout and excessive alcohol consumption were no longer associated with prevalent hypertension. Table 5 shows the crude and adjusted odds ratios (ORs) of hypertension control among treated patients. Male sex, high BMI and physical inactivity were associated with poor control of hypertension, while being from Regions other than Centre or Littoral was associated with good control (Table 5).

Hypertension control according to the number of risk factors

Hypertension control was assessed according to the clustering of cardiovascular risk factors including current or past smoking, self-reported diabetes, self-reported dyslipidemia, overweight or obesity, high waist and physical inactivity. Among 116 participants with none of the above, no case of hypertension was recorded. The proportion of patients at target BP levels among those treated steadily declined from 58.3% among those with only one risk factor to 11.8% among those with four or more risk factors (Figure 2). The declining trend was linear ($p<0.001$ for linear trend. In logistic regression models adjusted for sex, age and region, each additional cardiovascular risk factor from zero to four or more, reduced the chances of being at target BP levels by 70% (95% confidence interval: 49-82%). The range of effect was similar in men and women [OR (95% CI): 0.32 (0.14-0.71) in men and 0.30 (0.14-0.63) in women) with no evidence of significant statistical interaction ($p=0.17$ for interaction).

Discussion

In this self-selected urban adult population study from Cameroon, we found a high prevalence of hypertension, coupled with low detection, treatment and control rates. The high

prevalence was largely driven by age, as well as by gender and excess weight. However, among those diagnosed and on treatment, control rate was similar across age groups, although there were suggestions of regional differences, possibly reflecting underling differences in the access to healthcare and health resources utilization. The coincidence of cardiovascular risk factors in the same individual was associated with poor blood pressure control among treated participants. Our findings update previous reports on hypertension in Cameroon and provide comparative data across major cities in the country.

Prevalence of hypertension

During the last ten years, at least two prevalence studies on hypertension have been reported in urban Cameroon, applying similar definitions for hypertension, but different sampling strategies.[7 9 18] The age-adjusted prevalence of hypertension in the current study is higher than that reported by Kamadjeu[9] in 2003, but similar to the findings of Fezeu[7] around that same time. This balance of findings would tend to suggest that the prevalence of hypertension in this setting is either stabilizing or growing at a much slower pace than previously reported.[7]

Elsewhere, available data on hypertension in Africa are from very heterogeneous studies, and therefore offer less opportunities for reliable comparison.[3] Such heterogeneities include differences in sampling methods and study settings (predominance of hospital based study), the type of subjects enrolled, the measurements of blood pressure and definition of hypertension, and the time period when the study was conducted.[19] Reliable, large-scale, population-based data on high blood pressure in sub-Saharan Africa are very limited; however available recent studies provide findings that demonstrate similarly high prevalence of hypertension in urban settings.[20-22] Moreover, those findings already tend to be similar to those reported in the developed world,[23 24] therefore, raising serious concerns given the young age of clinical onset of hypertension in Africa.

Awareness, treatment and control of hypertension

In Cameroon, over the last ten years, there have been a number of initiatives aimed at scaling up the fight against chronic diseases in general, and hypertension and diabetes mellitus in particular,[25] including: 1) the adoption of a National Strategy for hypertension and diabetes;[25] and 2) the development of training and task-shifting programmes to improve detection and management at primary care level.[13 26] Findings from our study tend to suggest that the good will contained in the National Strategy has not yet been fully translated into actions with sizable positive effects on the health of the population. For instance, the Strategy aimed to improve level of risk factors by 25% and achieve optimal control among those diagnosed with the condition.[25] However, we found awareness, treatment and control rates which were within the range of those previous reported in Cameroon prior to the adoption of the Strategy[7 9] and recently in other settings in Africa.[20 22 25] The low awareness rate could be blamed on low detection activity and accordingly non-optimal performance of the National strategy. It is also possible that many participants already diagnosed with hypertension, and perhaps on treatment and controlled on such treatment, did not feel the need to attend the screening campaign again. This would have the undesirable effect of biasing our estimates by providing much lower than the true figures. It is also possible that those with known and treated condition instead turned out in higher number to use the campaign as an opportunity for their health checkup free of charge. In general however, low awareness of hypertension has been reported as a global phenomenon,[27] although the magnitude may be less important in the developed world[23 28]. In the USA for instance, awareness of hypertension is as higher as 76%,[28] reflecting the success achieved by a coordinated policy to detect individuals with higher-than-optimal blood pressure levels. The low treatment and control rates in our study reflect the interplay between many factors which were not directly captured by the current study. These include both patient-level,

healthcare provider level and health system level factors. Indeed, patients are expected to be treated and controlled only if they can access appropriate health services, receive adequate advice and prescriptions, and subsequently afford and adhere to those prescriptions. Accessibility to health care facility has likely improved in urban settings in Cameroon in recent years. However the physician-to-population ratio, just like in many other countries in the region, is still very low[29] and may explain the low awareness and treatment gaps. Affordability of the cost of care also remains a major barrier in the study setting where out-of-pocket spending is the main source of funding for healthcare costs. Adherence to prescribed medications is another patient-level determinant of risk factor control not investigated in the present study. Studies in Africa have shown that non-adherence to treatment and follow-up for hypertension was very common.[30-32] In one intervention study in Cameroon for instance, just about half of participants were still in the programme at 1-year of follow-up.[31]

Potential limitations and strengths of our study

The present study has some limitations. Participants were self-selected and may therefore not necessarily be representative of the general population in participating cities. Access to mass media (radio and television) is almost universal in major cities in the countries, and there is therefore no suggestion that advertisement of the campaign would have selectively reached certain portions of the population. It remains however; that participants in the study could still differ from the general population by being more or less health conscious, and having less severe disease for example, which could affect some parameters in the study. The study used a cross-sectional design, which precludes any causality inference. Diagnosis of hypertension was based on blood pressure measurements during a single encounter, which is at variant with guidelines recommendations for hypertension diagnosis using two measurements recorded on three separate occasions.[17] This may have overestimated the prevalence of hypertension and underestimated the level of blood pressure control. This however, would not affect

comparisons with previous epidemiological studies that have used similar measurement methodology. The strengths of this study include the large sample of the general population and, the rigorous collection of various lifestyle factors, medical data and blood pressure measurements by trained staff according to standardized protocols, the adequate standardization of prevalence and allowing comparisons with other African countries. In addition, our sampling approach provides evidence that simple announcements through mass media can attract from the community a large number of individual at risk of undiagnosed hypertension.

Conclusions

In conclusion, our study confirms the high prevalence of hypertension previously reported in urban settings in Africa. Detection, treatment and control efforts are still well below optimal. This raises serious concerns about the prospects of having to care very soon for both patients with higher-than-optimal blood pressure and many more with target organ lesions subsequent to longstanding hypertension. There are already some indications that the burden of stroke, end-stage renal disease and heart failure related to hypertension is growing in the country and the region.[2 6 33]

Perspectives

The low awareness, treatment and control rates of hypertension in this potentially health conscious urban sub-Saharan population invite innovative approaches to improve prevention, detection, treatment of hypertension beyond the traditional healthcare facilities based approaches which are currently in force in many countries in the region.

Declaration of competing interest. None for all authors.

Author contribution. Dzudie and Kengne had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Dzudie, Kengne, Muna, Ngu, Kingue.

Acquisition of data: Ba, Menanga, Kouam Kouam, Abah, Monkam, Biholong, Mintom, Kamdem, Djomou, Njebet, Ouambo, Luma,

Analysis and interpretation: Dzudie, Kengne, Muna

Drafting of the manuscript: Dzudie, Kengne, Muna

Critical revision of the manuscript for important intellectual content: all co-authors

Acknowledgements

The authors would like to express their gratitude to the following bodies and individuals for their contribution to the success of this study: 1) The Cameroon Ministry of public health for providing the blood pressure devices and health staff; 2) The executive committee and members of the Cameroon Cardiac Society for their support for data collection; 3) Servier Pharma Cameroon for a financial contribution to support data processing and drafting of the manuscript; 4) All specialist physicians, enthusiastic general practitioners, medical students and nurses involved in data collection; and 5) All those who helped at the different stages of the project and the fellow Cameroonians who volunteered across the four participating cities to take part in the study.

Data sharing statement: No additional data available

Appendix 1

Cameroon Cardiac Society (CCS) investigators group:

(1) Douala: Anastase Dzudie, Hamadou Ba, Henri Roger Ngote, Christian Biholong, Félicité Kamdem, Armel Djomou, Jules Njebet, Cyrille Ouambo, Roger Mboulley Kotto, Barbara Bouellet Abeng, Marielle Epacka Ewane Lobe and Yves Monkam.

(2) Yaounde : Alain Menanga, Pierre Mintom, Euloge Yiagnigni, Mérimée Ouankou, Christophe Nouedoui, Pierre Ndobo, Marie Ntep, Monique Kenfack, Sylvie Ndongo, Martine Tchuem, Edvine Wawo, Walinjom F.T. Muna, Katleen Ngu Blackett and Samuel Kingue.

(3) Bafoussam: Charles Kouam Kouam

(4) Bamenda: Joseph Abah.

References

1. Kearney PM, Whelton M, Reynolds K, et al. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005;365:217-23.

2. Kengne AP, Anderson CS. The neglected burden of stroke in Sub-Saharan Africa. *Int J Stroke* 2006;1:180-90.

3. Addo J, Smeeth L, Leon DA. Hypertension in sub-saharan Africa: a systematic review. *Hypertension* 2007;50:1012-8.

4. Kengne AP, Amoah AG, Mbanya JC. Cardiovascular complications of diabetes mellitus in sub-Saharan Africa. *Circulation* 2005;112:3592-601.

5. Damasceno A, Cotter G, Dzudie A, et al. Heart failure in sub-saharan Africa: time for action. *J Am Coll Cardiol* 2007;50:1688-93.

6. Kengne AP, Awah PK. Classical cardiovascular risk factors and all-cause mortality in rural Cameroon. *Qjm* 2009:doi:10.1093/qjmed/hcn175.

7. Fezeu L, Kengne AP, Balkau B, et al. Ten-year change in blood pressure levels and prevalence of hypertension in urban and rural Cameroon. *J Epidemiol Community Health* 2010;64:360-5.

8. Turnbull F. Effects of different blood-pressure-lowering regimens on major cardiovascular events: results of prospectively-designed overviews of randomised trials. *Lancet* 2003;362:1527-35.

9. Kamadjeu RM, Edwards R, Atanga JS, et al. Prevalence, awareness and management of hypertension in Cameroon: findings of the 2003 Cameroon Burden of Diabetes Baseline Survey. *J Hum Hypertens* 2006;20:91-2.

10. Leon DA. Cities, urbanization and health. *Int J Epidemiol* 2008;37:4-8.

11. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr* 2006;84:289-98.

12. de-Graft Aikins A, Unwin N, Agyemang C, et al. Tackling Africa's chronic disease burden: from the local to the global. *Globalization and health* 2010;6:5.

13. Lekoubou A, Awah P, Fezeu L, et al. Hypertension, diabetes mellitus and task shifting in their management in sub-Saharan Africa. *Int J Environ Res Public Health* 2010;7:353-63.

14. Cameroon's National Institute of Statistics. Statistical Yearbook 2010, 2011:39-52.

15. Cameroon's National Institute of Statistics. Population du Cameroun en 2010, 2011.

16. Woodward M, editor. *Epidemiology: study design and data analysis*. Second ed. New York: Chapman & Hall/CRC, 2005.

17. Mancia G, De Backer G, Dominiczak A, et al. 2007 Guidelines for the Management of Arterial Hypertension: The Task Force for the Management of Arterial Hypertension

of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2007;25:1105-87.

18. Kengne AP, Awah KP, Fezeu L, et al. The burden of high blood pressure and related risk factors in urban sub-Saharan Africa: Evidences from Douala in Cameroon. *African Health Sciences* 2007;7:38-44.
19. Danaei G, Finucane MM, Lin JK, et al. National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5.4 million participants. *Lancet* 2011;377:568-77.
20. Jenson A, Omar AL, Omar MA, et al. Assessment of hypertension control in a district of Mombasa, Kenya. *Glob Public Health* 2011;6:293-306.
21. Ulasi, II, Ijoma CK, Onodugo OD. A community-based study of hypertension and cardio-metabolic syndrome in semi-urban and rural communities in Nigeria. *BMC Health Serv Res* 2010;10:71.
22. Damasceno A, Azevedo A, Silva-Matos C, et al. Hypertension prevalence, awareness, treatment, and control in mozambique: urban/rural gap during epidemiological transition. *Hypertension* 2009;54:77-83.
23. Wagner A, Sadoun A, Dallongeville J, et al. High blood pressure prevalence and control in a middle-aged French population and their associated factors: the MONA LISA study. *J Hypertens* 2011;29:43-50.
24. Wolf-Maier K, Cooper RS, Banegas JR, et al. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. *Jama* 2003;289:2363-9.
25. Njamnshi AK, Bella Hiag A, Mbanya JC. From research to policy: the development of a national diabetes programme in Cameroon. *Diabetes Voice* 2006;55:18-21.

26. Kengne AP, Sobngwi E, Fezeu L, et al. Setting-up nurse-led pilot clinics for the management of non-communicable diseases at primary health care level in resource-limited settings of Africa *PAMJ* 2009;3:10.

27. Marques-Vidal P, Tuomilehto J. Hypertension awareness, treatment and control in the community: is the 'rule of halves' still valid? *J Hum Hypertens* 1997;11:213-20.

28. Cheung BM, Ong KL, Man YB, et al. Prevalence, awareness, treatment, and control of hypertension: United States National Health and Nutrition Examination Survey 2001-2002. *J Clin Hypertens (Greenwich)* 2006;8:93-8.

29. World Health Organisation. Task shifting to tackle health worker shortage. Geneva, 2007.

30. Kengne AP, Awah PK, Fezeu LL, et al. Primary health care for hypertension by nurses in rural and urban sub-Saharan Africa. *J Clin Hypertens (Greenwich)* 2009;11:564-72.

31. Labhardt ND, Balo JR, Ndam M, et al. Improved retention rates with low-cost interventions in hypertension and diabetes management in a rural African environment of nurse-led care: a cluster-randomised trial. *Trop Med Int Health* 2011.

32. Dennison CR, Peer N, Steyn K, et al. Determinants of hypertension care and control among peri-urban Black South Africans: the HiHi study. *Ethn Dis* 2007;17:484-91.

33. Halle MP, Kengne AP, Ashuntantang G. Referral of patients with kidney impairment for specialist care in a developing country of sub-Saharan Africa. *Ren Fail* 2009;31:341-8.

Legend for figures and tables

Figure 1: Mean systolic and diastolic blood pressure by age groups for men (left panel) and women (right panel).

Figure 2 – Blood pressure control among participants with hypertension according to the number of cardiovascular risk factors.

Risk factors considered were: overweight or obesity, high waist, current or past smoking, physical inactivity, diagnosed diabetes, dyslipidemia. None of the 116 participants with none of the risk factor had hypertension.

Table 1 - General characteristics of the study population overall and by Region

Characteristic	Regions										Overall		
	Centre			Littoral			North-West and West			p region			
	Men	Women	P	Men	Women	P	Men	Women	p		Men	Women	p
N	376	273		609	558		132	172		<0.001	1117	1003	
Mean age, yrs. (SD)	41 (12)	42 (14)	0.43	45 (13)	43 (14)	0.33	48 (14)	45 (14)	0.08	<0.001	44 (13)	43 (14)	0.19
Age groups, n			0.26			0.006			0.22	<0.001			0.01
<35 years	134	97		145	180		23	44			302	321	
35-44 years	99	57		154	108		32	40			285	205	
45-54 years	86	65		163	139		34	47			284	251	
≥55 years	57	54		146	131		43	41			246	226	
Mean BMI, kg/m^2 (SD)	26.2 (4.0)	27.2 (4.5)	0.002	26.9 (4.8)	29.0 (6.3)	<0.001	27.6 (5.0)	29.3 (5.4)	0.006	<0.001	26.7 (4.6)	28.6 (5.8)	<0.001
Waist girth, cm (SD)	96 (13)	94 (12)	0.04	91 (13)	91 (15)	0.31	95 (12)	97 (12)	0.15	<0.001	93 (13)	93 (14)	0.80
Mean SBP, mmHg (SD)	133 (22)	129 (24)	0.06	142 (26)	139 (30)	0.05	136 (25)	125 (25)	<0.001	<0.001	139 (25)	134 (28)	<0.001
Mean DBP, mmHg (SD)	77 (17)	77 (16)	0.98	85 (17)	82 (18)	0.001	85 (15)	79 (15)	0.001	<0.001	83 (17)	80 (17)	0.001
Parental hypertension, n	77	77	0.02	158	191	0.002	38	55	0.62	0.01	273	323	<0.001
History of diabetes, n	27	27	0.22	27	31	0.42	21	31	0.65	<0.001	75	89	0.07
History of dyslipidemia, n	1	0	>0.99	4	9	0.16	0	0	N/A	0.005	5	9	0.28
History of gout, n	0	1	0.42	13	9	0.53	1	0	0.43	<0.001	14	10	0.68
Physical activity, n	160	86	0.004	334	180	<0.001	82	104	0.77	<0.001	576	370	<0.001
Smoking, n			<0.001			<0.001			<0.001	0.07			<0.001
Never	320	267		500	540		113	170			933	977	
Former	21	26		43	7		4	0			68	12	
Current	35	36		66	11		15	2			116	14	
Excessive alcohol, n	85	17	<0.001	147	51	<0.001	51	32	<0.001	<0.001	283	100	<0.001

BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; SD, standard deviation

Table 2 - Prevalence of Blood Pressure categories by sex and age group among self-selected urban dwellers in Cameroon

Gender	Variable	Overall	Overall*	Age groups				P-trend
				<35 years	35-44 years	45-54 years	≥55 years	
Men	Isolated systolic hypertension (%)	19.1	16.6 (15.1-18.1)	4.7	2.9	4.9	6.5	<0.001
	Optimal blood pressure (%)	21.6	23.1 (21.6-24.6)	8.0	7.3	3.9	2.3	<0.001
	Normal blood pressure (%)	19.8	19.8 (18.3-21.3)	6.7	5.4	5.5	2.2	<0.001
	High normal blood pressure (%)	16.7	17.6 (16.1-19.1)	6.2	4.6	3.5	2.3	<0.001
	Grade 1 hypertension (%)	12.4	9.7 (8.2-11.2)	2.5	3.1	3.9	2.8	0.09
	Grade 2 hypertension (%)	11.7	8.0 (6.5-9.5)	1.5	2.8	3.5	4.0	<0.001
	Grade 3 hypertension (%)	9.6	5.2 (3.7-6.7)	0.4.	2.0	2.8	4.4	<0.001
Women	Isolated systolic hypertension (%)	13.3	10.9 (9.4-12.4)	2.7	2.2	2.8	5.6	<0.001
	Optimal blood pressure (%)	29.6	38.0 (36.5-39.5)	15.3	6.0	5.2	3.1	<0.001
	Normal blood pressure (%)	17.4	19.0 (17.5-20.5)	6.6	4.6	3.8	2.4	0.001
	High normal blood pressure (%)	13.9	13.0 (11.5-14.5)	3.8	3.1	3.7	3.3	0.34
	Grade 1 hypertension (%)	9.9	8.3 (6.8-11.8)	2.0	2.6	3.2	2.1	0.13
	Grade 2 hypertension (%)	8.1	6.0 (4.5-7.5)	1.3	0.7	2.9	3.5	<0.001
	Grade 3 hypertension (%)	8.1	5.8 (4.3-7.3)	0.4	1.3	2.8	5.6	<0.001

* Age standardized according to the 2010 Cameroon national population distribution.

Table 3 - Hypertension prevalence, awareness and control among self-selected urban dwellers in Cameroon

Gender	Variable	Overall	Overall*	Age groups				P-trend
				<35 years	35-44 years	45-54 years	≥55 years	
Men	Prevalence (%)	50.1	41.3 (39.8-42.8)	31.7	38.9	57.2	77.6	<0.001
	SBP≥140 or DBP≥90 mmHg or treatment (n)	560	560	96	111	162	191	
	Awareness (%)	24.6	13.5 (8.9-18.1)	6.3	12.6	21.6	43.5	<0.001
	Among hypertensives (n)	138	138	6	14	35	83	
	Treatment (%)	57.9	54.6 (-17.6 to 126.8)	50	64.2	65.7	54.2	0.53
	Among aware hypertensives	80	80	3	9	23	45	
	Control A (%)	18.8	28.2 (-115.9 to 172.3)	33.3	22.2	21.7	15.5	0.37
	Among treated hypertensive (n)	15	15	1	2	5	7	
	Control B (%)	27.5	50.3 (-93.8 to 14.4)	66.6	22.2	26.1	26.7	0.50
	Among treated hypertensive (n)	22	22	2	2	6	12	
Women	Prevalence (%)	44.6	32.5 (31.0-34.0)	20.2	35.6	55.8	75.2	<0.001
	SBP≥140 or DBP≥90 mmHg or treatment (n)	447	447	64	73	140	170	
	Awareness (%)	40.5	20.9 (13.8-28.0)	9.3	26.0	42.8	54.5	<0.001
	Among hypertensives (n)	181	181	6	19	60	96	
	Treatment (%)	61.3	43.3 (-30.4 to 117.0)	33.3	57.9	53.3	68.9	0.03
	Among aware hypertensives	111	111	2	11	32	66	
	Control A (%)	28.8	8.0 (-212.6 to 228.6)	0	18.1	21.8	34.8	0.27
	Among treated hypertensive (n)	32	32	0	2	7	23	
	Control B (%)	38.7	12.8 (-207.8 to 233.4)	0	2.7	31.3	45.5	0.06
	Among treated hypertensive (n)	43	43	0	3	10	30	

Data are percentages with numerators below. Control A, blood pressure below 140/90 mmHg or 130/80 mmHg among diabetic patients; Control B, blood pressure below 140/90 mmHg among all subjects. DBP, diastolic blood pressure; SBP, systolic blood pressure.

* Age standardized according to the 2010 Cameroon national population distribution.

Table 4 - Crude and adjusted odds ratios for predictors of hypertension among self-selected urban dwellers in Cameroon.

Variable	Category	Unadjusted odd ratios (95% CI)	p	Adjusted odd ratios (95% CI)*	p
Sex	Men	1.25 (1.05-1.48)	0.01	1.63 (1.34-2.00)	<0.001
Age	<35 years	1 (reference)	<0.001	1 (Reference)	<0.001
	35-44 yrs	1.74 (1.35-2.25)		1.32 (1.01-1.73)	
	45-54 yrs	3.75 (2.93-4.81)		2.81 (2.16-3.64)	
	≥55 yrs	9.41 (7.12-12.43)		8.27 (6.19-11.04)	
Region	Centre	1 (Reference)	<0.001	1 (Reference)	<0.001
	Littoral	2.11 (1.73-2.57)		1.89 (1.52-2.36)	
	Others	1.80 (1.36-2.37)		1.38 (1.01-1.89)	
Parental hypertension	Yes	1.47 (1.21-1.77)	<0.001	1.55(1.25-1.92)	<0.001
Diabetes mellitus	Yes	3.77 (2.61-5.44)	<0.001	2.63 (1.75-3.94)	<0.001
Dyslipidemia	Yes	2.00 (0.67-5.98)	0.22	1.55 (0.47-5.11)	0.47
Gout	Yes	3.36 (1.33-8.49)	0.01	1.70 (0.62-4.67)	0.30
Smoking	Never	1 (Reference)	0.11	1 (Reference)	0.62
	Former	1.59 (1.01-2.51)		0.96 (0.59-1.65)	
	Current	0.90 (0.63-1.29)		0.82 (0.54-1.22)	
Physical activity	No	0.90 (0.76-1.07)	0.23	1.13 (0.93-1.38)	0.21
Excessive alcohol	Yes	1.33 (1.06-1.66)	0.01	1.05 (0.81-1.36)	0.70
Body mass index	Normal	1 (Reference)	<0.001	1 (Reference)	<0.001
	Overweight	2.03 (1.65-2.50)		1.94 (1.54-2.45)	
	Obese	3.54 (2.83-4.43)		3.32 (2.57-4.29)	
High waist girth		2.12 (1.78-2.52)	<0.001	1.94 (1.51-2.48)	<0.001

* age, sex, parental history of hypertension, body mass index and region adjusted; CI, confidence interval

Table 5 - Crude and adjusted odds ratios for predictors of hypertension control among self-selected and treated hypertensives in four main cities of Cameroon.

Variable	Category (%)	Unadjusted odd ratios (95% CI)	P	Adjusted odd ratios (95% CI)*	p
Sex	Men	059 (0.35-1.00)	0.05	0.47 (0.26-0.86)	0.01
Age	<35 years	1.00 (Reference)	0.87	1.00 (Reference)	0.63
	35-44 yrs	0.54 (0.12-2.32)		0.38 (0.07-1.99)	
	45-54 yrs	0.68 (0.19-2.45)		0.57 (0.13-2.41)	
	≥55 yrs	0.67 (0.19-2.34)		0.46 (0.11-1.88)	
Region	Centre	1.00 (Reference)	<0.001	1.00 (Reference)	<0.001
	Littoral	0.72 (0.35-1.50)		0.70 (0.33-1.52)	
	Others	3.36 (1.64-6.87)		3.50 (1.65-7.42)	
Parental hypertension	Yes	1.44 (0.87-2.40)	0.16	1.56 (0.89-2.75)	
Diabetes mellitus	Yes	2.73 (1.60-4.67)	<0.001	1.83 (0.98-3.39)	0.06
Dyslipidemia	Yes	0.74 (0.08-6.75)	0.79	1.30 (0.13-13.26)	0.83
Gout	Yes	NA (None)			
Smoking	Never	1.00 (Reference)	0.53	1.00 (Reference)	0.72
	Former	0.79 (0.21-2.89)		1.26 (0.30-5.34)	
	Current	0.32 (0.04-2.57)		0.44 (0.05-3.97)	
Physical activity	No	0.30 (0.17-0.56)	<0.001	0.36 (0.20-0.66)	0.001
Excessive alcohol	Yes	0.59 (0.26-1.32)	0.20	0.64 (0.26-1.60)	0.34
Body mass index	Normal	1.00 (Reference)	0.002	1.00 (Reference)	0.003
	Overweight	0.41 (0.22-0.77)		0.44 (0.22-90)	
	Obese	0.34 (0.18-0.66)		0.28 (0.14-0.59)	
High waist girth		0.86 (0.51-1.44)	0.56	0.77 (0.33-1.77)	0.54

* age, sex, parental history of hypertension, body mass index and region adjusted; CI, confidence interval.

Figure 1:

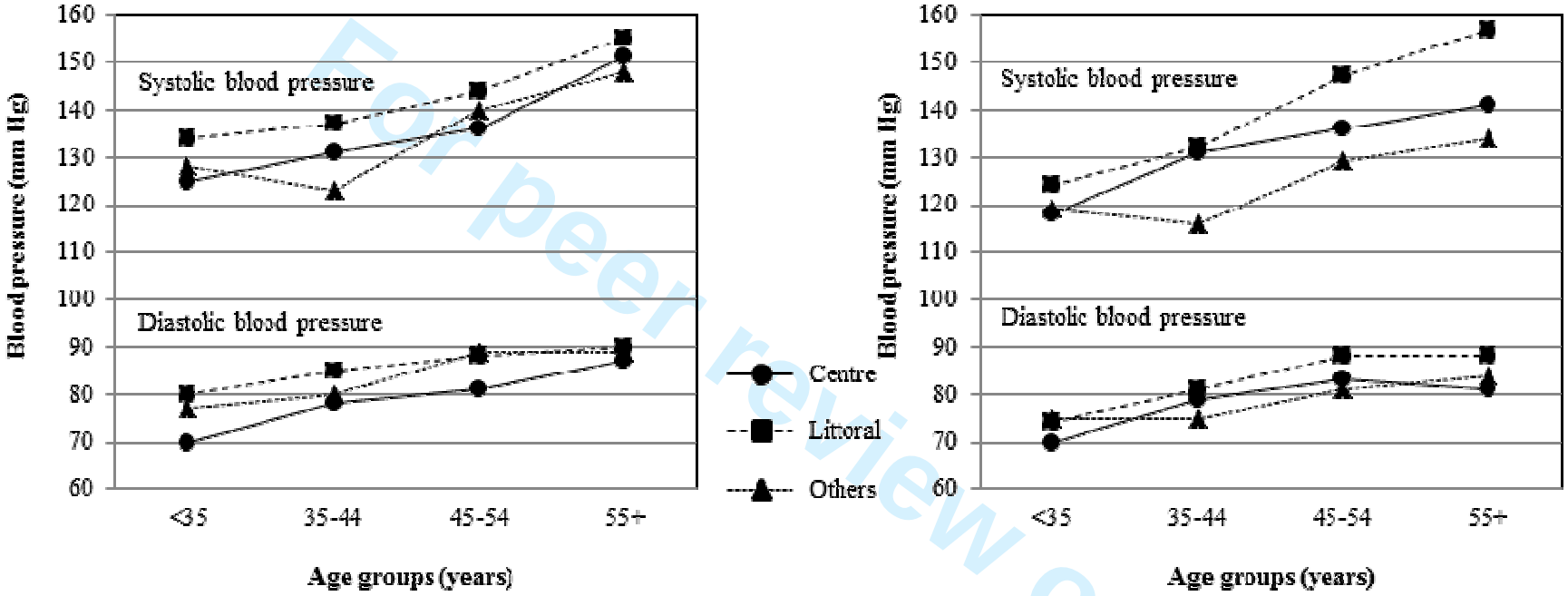
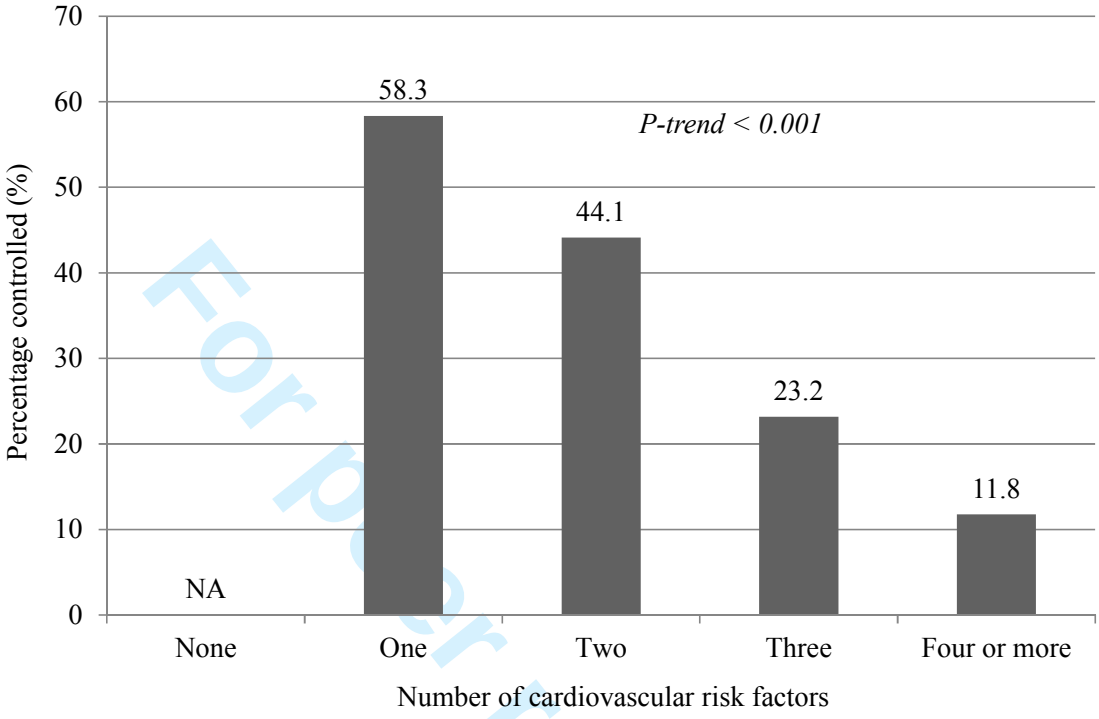


Figure 2



STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any pre-specified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	8-9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	8-9

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-001217.R1
Article Type:	Research
Date Submitted by the Author:	02-Jul-2012
Complete List of Authors:	Dzudie, Anastase Kengne, Andre; South African Medical Research Council, National Collaborative Programme on Cardiovascular and metabolic Disease; The George Instute for Global Health, Muna, Walinjom Ba, Hamadou Menanga, Alain Kouam Kouam, Charles Abah, Joseph Monkam, Yves; General Hospital of Douala, Department of Internal Medicine Biholong, Christian; General Hospital of Douala, Department of Internal Medicine Mintom, Pierre Kamdem, Felicite; General Hospital of Douala, Department of Internal Medicine Djomou, Armel; General Hospital of Douala, Department of Internal Medicine Ndjebet, Jules; General Hospital of Douala, Department of Internal Medicine Ouambo, Cyrille Luma, Henry; General Hospital of Douala, Department of Internal Medicine Ngu, Kathleen Kingue, Samuel
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Cardiovascular medicine, Epidemiology
Keywords:	Hypertension < CARDIOLOGY, EPIDEMIOLOGY, PUBLIC HEALTH

Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Short title: Awareness, treatment and control of hypertension

Anastase Dzudie, MD, FESC(1); André Pascal Kengne, MD, PhD(2); Walinjom F.T. Muna, MD, PhD, FACC(3); Hamadou Ba, MD(1); Alain Menanga, MD (4); Charles Kouam Kouam, MD(5); Joseph Abah, MD(6); Yves Monkam, MD(1); Christian Biholong, MD(1); Pierre Mintom, MD(4); Félicité Kamdem, MD(1); Armel Djomou, MD(1); Jules Ndjebet, MD(1); Cyrille Ouambo, MD, PhD(1); Henri Luma, MD(1), Katleen Blackett Ngu, MD, FESC(6); Samuel Kingue, MD(6); On behalf of the CCS investigator group*.

(1) Department of Internal Medicine, Douala General Hospital and Buea Faculty of medicine, Cameroon

(2) NCRP or Cardiovascular and metabolic disease, South African Medical Research Council & University of Cape Town, Cape Town, South Africa

(3) Department of Internal Medicine, Faculty of Medicine and Biomedical Sciences, Yaounde, Cameroon

(4) Department of Internal Medicine, Yaounde General Hospital , Cameroon

(5) Department of Internal Medicine, Bafoussam Regional Hospital , Cameroon

(6) Department of Internal Medicine, Bamenda Military Hospital , North West Region, Cameroon

Correspondence to: Dr Anastase Dzudie, MD; FESC. Douala General Hospital; PO Box 4856, Douala General Hospital, Douala – Cameroon, Tel: +(237)79617981; Fax: +(237)33370146; email: aitdzudie@yahoo.com

Tables #4; Figures #1.

Word count: Abstract (265); Main text excluding reference, figure legend and references (3720)

* Members list in the appendix section

Abstract

Objectives. Hypertension has been established as a major public health problem in Africa, but its specific contributions to disease burden are still incompletely understood. We quantified the burden and determinants of hypertension, detection, treatment and control rates among adults in major cities in Cameroon.

Design. Cross-sectional study

Settings. Community-based multicenter study in major cities in Cameroon

Participants. Participants were self-selected urban dwellers from the Center, Littoral, North-West and West Regions, who attended on May 17th 2011 a screening campaign advertised through mass media.

Primary and secondary outcomes measures. Hypertension defined as systolic (and/or diastolic) blood pressure ≥ 140 (90) mmHg, or ongoing blood pressure (BP) lowering medications.

Results. In all, 2120 participants (1003 women) were included. Among them, 1007 (prevalence rate 47.5%) had hypertension, including 319 (awareness rate 31.7%) who were aware of their status. The prevalence of hypertension increased with age overall and by sex and region. Among aware hypertensive participants, 191 (treatment rate 59.9%) were on regular BP lowering medication, and among those treated, 47 (controlled rate 24.6%) were at target BP levels (i.e. systolic (and diastolic) BP <140 (90) mmHg). In multivariable logistic regressions analysis, male gender, advanced age, parental history of hypertension, diabetes mellitus, elevated waist, and elevated body mass index (BMI) were the significant predictors of hypertension. Likewise, male gender, high BMI and physical inactivity were associated with poor control.

Conclusions. High prevalence of hypertension with low awareness, treatment and control were found in this urban population; these findings are significant and alarming with

consideration to the various improvements in the access to healthcare and the continuing efforts to educate communities over the past decades.

Word count - 265

Key Words: Hypertension, prevalence, awareness, treatment, control, Cameroon, Africa

Article summary

Article focus

- This article quantified the burden and determinants of hypertension, detection, treatment and control rates among self-selected adults in major cities in Cameroon, central Africa

Key messages

- The prevalence of hypertension was very high in this population, coupled with low detection, treatment and control rates.
- Age, gender and excess weight were the main drivers of the high prevalence, while the coincidence of classical cardiovascular risk factors was associated with poor control.

Strengths and limitations of this study

- Major strengths of this study include the large sample, the multicenter nature, the rigorous data collection on a range of determinants and provision of standardized prevalence figures.
- Limitations include the selection of participants, and hypertension diagnosis based on blood pressure measurement during a single encounter.

Introduction

Hypertension has been established as a major public health problem worldwide.[1] Several published studies suggest that hypertension is the commonest modifiable risk factor for stroke, congestive heart failure and kidney failure[2-5] in the sub-Saharan African (SSA) region. It is a major contributor to overall mortality risk in adults in the region.[6] Hypertension also seems to be more common in urban than rural population[7] of the SSA region.

Specific risks associated with various blood pressure (BP) readings have largely been established for populations in many parts of the developed world but this is not the case for countries of the developing world including the SSA region. There is considerable evidence that long-term BP lowering to what is considered either normal or optimal levels results in several significant and important health benefits.[8] When established norms for ideal or optimal BP are applied to SSA populations, it becomes very evident that the vast majority of eligible patients do not enjoy the benefits of BP lowering therapies, either because of under-diagnosis or the many other barriers to BP lowering medications prescription, access and compliance in this setting.[1 2] As a case in point, a survey in Cameroon about eight years ago found that only 23% of all individuals with hypertension at the community level were aware of their status.[9] Moreover, only 46% of those aware (11% of all those with hypertension) were on treatment, among whom only 19% (2% of all those with hypertension) achieved expected target BP levels.[9]

There is also evidence that SSA is undergoing very rapid transitions characterized by increasing urbanization, including the adoption of unhealthy lifestyles.[10 11] These transitions are paralleled by changes in the profile of chronic disease risk factors including

blood pressure.[7] Recently there has been increasing awareness of the threat that the looming chronic diseases pose to the health of the population in the Region at different levels.[12] This increasing awareness has catalyzed initiatives aimed at improving access to detection and care of chronic diseases including hypertension[13] in many countries of the region. The pace of the above mutations suggests that, data on the burden of hypertension, must be updated regularly, in order to provide the reliability needed in drawing-up health service and policy solutions.

The aim of this study was to assess the prevalence and determinants of hypertension, and including the detection, treatment and control rates, as well as the variability by region and gender in four major cities of Cameroon.

Material and methods

Study population and settings

This was a cross-sectional population-based study conducted in the regional capitals of the Centre (Yaounde), Littoral (Douala), North-West (Bamenda) and West (Bafoussam) administrative regions (out of a total of ten) of Cameroon. According to the Cameroon National Institute of Statistics,[14] the four participating regions had a total population of 9.98 million in 2010 (51% of the country's total population: 19.41 millions). In this same year, 57.5% of the national population was aged 15 years and above, and about 52% resided in what was defined as an urban area.[14] During three consecutive weeks leading to the specified day of the survey, daily announcements were made through radio and television, inviting all interested adults (or individuals aged 15 years and above) to report to any of the screening sites in participating cities. Such explanation included advice on the importance of measuring and knowing one's blood pressure under the slogan "I know my blood pressure. And you?". Announcements were also made in churches and market places. The study

protocol was approved by the Cameroon National Ethics Committee and signed informed consent obtained from each participant.

Data collection

The screening was conducted by trained medical personnel, simultaneously in the four cities on the specified date of May 17th 2011. All participants were subjected to a face-to-face interview during which data were collected (using a standardized questionnaire) on demographics, smoking habits and alcohol consumption, physical activity, parental history of hypertension, personal medical history (where the diagnosis was made by a physician) of hypertension including drug treatment, diabetes mellitus, gout and dyslipidemia. The physical examination included blood pressure (BP) and anthropometric measurements. BP (systolic and diastolic) was measured using a standardized protocol with the participant in a seated position, and after at least 10 minutes rest. Participants with evidence of recent (less than 30 minutes) alcohol intake or smoking were invited to a 30 minutes rest before BP measurement. BP measurements were performed on the right arm using automated sphygmomanometers (OMRON M3 HEM-7200-E Omron Matsusaka Co Ltd, Japan). Special attention was given to the use of appropriate cuff sizes (13×23 cm or 16×30 cm). Weight (to the nearest 0.5 kg) was measured with the use of an automated scale. Participants were permitted to keep on light clothing. Height (in meters to the nearest 0.5cm) was measured using a wooden platform and a height rule. Body mass index (BMI in kg/m^2) was calculated as weight (kg)/[height (m) X height (m)]. Waist circumference was measured midway between the iliac crest and the lower rib margin and the hip circumference was measured at the intertrochanteric level. Waist-to-hip ratio (WHR) was calculated as waist (cm)/Hip (cm) circumferences.

Definitions

Respondents were classified as hypertensive if they had a systolic (and/or diastolic) BP of 140 (90) mmHg or higher, or if they were on blood pressure lowering medications over the last 15 consecutive days. Participants with hypertension were considered to be aware of their status if they answered 'yes' to the question 'have you ever been told by a doctor or health professional that you had hypertension?'. Treatment of high BP was defined by the use of BP lowering medications. Hypertension was considered to be controlled among treated individuals when systolic (and diastolic) SBP was < 140 (90) mmHg or <130 (80) mmHg in individuals with diabetes. Waist circumference >94 cm in men or 80 cm in women was considered to be high. Excessive alcohol consumption was based on intake of either more than three (two for women) standard glasses of wine per day or more than ten (five for women) local beers (1 local beer contains 28 g of alcohol) per week. Traditional alcohol beverages were not assessed. Participants who smoked at least one cigarette per day at the time of the study were classified as current smokers, and those who have smoked for at least 3 years in the past, but had stopped by the time of the study were classified as former smokers. Regular non-work related physical activity was considered in participants reporting at least 30 min of intense physical activity, once a week or more.

Handling of participants with high blood pressure

Participants with hypertension (known or screened-detected) received on-site medical counseling and were referred back to their attending physician (known cases), or to specialists within the vicinity of the participant's residential area for workup and long-term management. Few participants with excessively high BP with or without suspected acute target organ damage were immediately referred to emergency departments for appropriate care.

Statistical analysis

Data analysis used the Statistical Package for Social Sciences (SSPS Inc, Chicago, IL) version 17.0 software. Results are summarized as count and percentages for qualitative variables and

mean and standard deviation (SD) for quantitative variables. Age-adjusted prevalence was calculated using the Cameroon National population's age structure in 2010 as standard population.[15] Direct standardization methods was applied.[16] Group comparisons used chi square tests and equivalents for qualitative variables and Student t-test, analysis of the variance (ANOVA) for quantitative variables. Logistic regressions analyses were used to investigate potential determinants of prevalent hypertension and control. A p-value<0.05 was used to characterize statistically significant results.

Sensitivity analysis

The main analyses were based on a single blood pressure measurement. To assess the potential effects of 'regression to the mean' phenomenon on the prevalence of hypertension, a sensitivity analysis was conducted among participants with a raised initial blood pressure (SBP/DBP>=140/80 mmHg) and who had their blood pressure taken a second time on the same day. This analysis was based on the average of the first and second measurements.

Results

The study population

Two thousand one hundred and twenty eligible participants reported for screening in the four regions including 649 (30.6%) in the Centre, 1167 (54.1%) in the Littoral and 304 (14.3%) in the West and North West regions. Their overall profile including gender and region is summarized in Table 1. Participants included 1003 women (47.3%). Compared with men, women had similar age (43 vs. 44 years, p=0.19), similar waist circumference (93 vs. 93 cm, p=0.80), and similar history of diabetes mellitus, dyslipidemia and gout (all p≥0.07, Table 1). They were likely to have higher body mass index, higher prevalence of parental history of hypertension, lower systolic and diastolic blood pressure, and were less likely to be either a smoker or alcohol drinker and physically active (all p≤0.001. Table 1). With a few

exceptions, the above pattern was consistent within participating regions. However, the small numbers of recruits in some subgroups translated into non-significant men/women differences (Table 1). With the exception of smoking (p=0.07), differences were also apparent in the baseline profile across Regions (all p≤0.01 for differences across regions).

Blood pressure profile

Mean systolic and diastolic BP (SD) at the total population level (men vs. women) was 139 (25) vs. 134 (28) mmHg (p<0.001), and 83 (17) vs. 80 (17) mmHg (p=0.001). Mean systolic BP steadily increased with increasing age in men and women and across participating regions. Diastolic BP also increased with increasing age, but only up to the fourth and fifth decade of age, after which the pressure stabilized. This was observed in men and women and across regions (Figure 1).

The distribution of participants by BP categories according to the 2003 ESH/ESC classification [17] was examined by sex and regions, overall and by age groups ~~is provided in Table 2~~. An optimal BP was observed in 21.6% of men and 29.6% of women. The prevalence of optimal or normal BP decreased with increasing age in men and women (all p≤0.001 for linear trend). Conversely, with the exception of grade 1 hypertension (both p≥0.09 for linearity) and high normal BP in women only (p=0.13), the prevalence of all other BP categories linearly increased with increasing age (all p<0.001 for linear trend~~, Table 2~~). Similar trends were also observed across participating regions. However, the distribution of participants across BP categories varied significantly by region (p<0.0001~~, Table 2~~)

Prevalence of hypertension, and awareness and control rates

The prevalence of hypertension was 47.5% overall, and 50.1% and 44.6% in men and women respectively (p<0.001), Table 3. As expected, prevalence rate sharply increased with age down from 31.7% (men) and 20.2% (women) in the age group <35 years, up to 77.6% (men) and 75.2% (women) in the age group 55 years and above (Table 3). Awareness rate increased

with increasing age in men and women (both p<0.001 for linear trend). Among participants with hypertension, 24.6% in men and 40.5% in women were aware of their condition, and those remaining were newly diagnosed. Of those aware of their hypertensive status, 57.9% in men and 61.3% in women were on BP lowering medications, similarly across age groups in men (p=0.53 for linear trend), and with a modest linearly increasing trend with age in women (p=0.03, Table 3). Among treated patients, 27.5% in men and 38.7% in women were at target BP levels [i.e. systolic (and diastolic) BP <140 (90) mmHg), and similarly across age strata (both p≥0.06 for linear trend). Control rate was about 10% lower when the target BP level of <130 (80) was applied to participants with diabetes (Table 3).

Crude prevalence of hypertension, awareness and treatment varied significantly across participating regions (all p<0.001). The highest crude prevalence (53.6%) was observed in the Littoral region, while the highest crude awareness (60.9%) and treatment rates (49.0%) were observed in provinces other than Centre ad Littoral (Table 3). Control rate was also higher in those two region when the threshold level of 140/90 mmHg was applied to all treatments participants (p<0.001). This difference however was non-significant when the threshold of 130/80 mmHg was applied to participants with diabetes. The age trends in prevalence, awareness, treatment and control across regions were largely similar to those observed in men and women (Table 3).

Predictors of hypertension and control among urban dwellers

In unadjusted logistic regressions analysis, male gender, increasing age, Region, parental history of hypertension, personal history of diabetes, gout, excessive alcohol consumption, high BMI and high waist circumference were associated with prevalent hypertension (Table 4). In multivariable adjusted models, history of gout and excessive alcohol consumption were no longer associated with prevalent hypertension. Table 5 shows the crude and adjusted odds ratios (ORs) of hypertension control among treated patients. Male sex, high BMI and physical

inactivity were associated with poor control of hypertension, while being from Regions other than Centre or Littoral was associated with good control (Table 5).

Sensitivity analysis

Among participants with newly diagnosed hypertension based on the first blood pressure measurement (688 participants), 537 (78.0%) had a valid second measurement. Their mean blood pressure (SD) was 159.4 (19.0) for systolic and 94.4 (14.2) mmHg for diastolic based on the first measurement. Equivalents were 154.5 (19.0) and 93.0 (13.1) mmHg based on the average of the two measurements. Of the 537 participants 461 (85.8%) had hypertension (systolic/diastolic blood pressure>=140/90 mmHg) using the average of the two blood pressure measurements.

Discussion

In this self-selected urban adult population study from Cameroon, we found a high prevalence of hypertension, coupled with low detection, treatment and control rates. The high prevalence was largely driven by age, as well as by gender and excess weight. However, among those diagnosed and on treatment, control rate was similar across age groups, although there were suggestions of regional differences, possibly reflecting underling differences in the access to healthcare and health resources utilization. Our ~~findings update previous reports on hypertension in Cameroon and~~ study provides comparative data across major cities in ~~the country~~Cameroon and suggests findings compatible with previously reported high prevalence rates of hypertension in the country.

Prevalence of hypertension

During the last ten years, at least two prevalence studies on hypertension have been reported in urban Cameroon, applying similar definitions for hypertension, but different sampling strategies.[7 9 18] The age-adjusted prevalence of hypertension in the current study is higher

than that reported by Kamadjeu[9] in 2003, but similar to the findings of Fezeu[7] around that same time. This balance of findings would tend to suggest that the prevalence of hypertension in this setting is either stabilizing or growing at a much slower pace than previously reported.[7]

Elsewhere, available data on hypertension in Africa are from very heterogeneous studies, and therefore offer less opportunities for reliable comparison.[3] Such heterogeneities include differences in sampling methods and study settings (predominance of hospital based study), the type of ~~subjects~~ participants enrolled, the measurements of blood pressure and definition of hypertension, and the time period when the study was conducted.[19] Reliable, large-scale, population-based data on high blood pressure in sub-Saharan Africa are very limited; however available recent studies provide findings that demonstrate similarly high prevalence of hypertension in urban settings.[20-22] Moreover, those findings already tend to be similar to those reported in the developed world,[23 24] therefore, raising serious concerns given the young age of clinical onset of hypertension in Africa.

Awareness, treatment and control of hypertension

In Cameroon, over the last ten years, there have been a number of initiatives aimed at scaling up the fight against chronic diseases in general, and hypertension and diabetes mellitus in particular,[25] including: 1) the adoption of a National Strategy for hypertension and diabetes;[25] and 2) the development of training and task-shifting programmes to improve detection and management at primary care level.[13 26] Findings from our study would tend to suggest that the good will contained in the National Strategy has perhaps not yet been fully translated into actions with sizable positive effects on the health of the population. For instance, the Strategy aimed to improve level of risk factors by 25% and achieve optimal control among those diagnosed with the condition.[25] However, we found awareness, treatment and control rates which were within the range of those previous reported in

Cameroon prior to the adoption of the Strategy[7 9] and recently in other settings in Africa.[20 22 25] The low awareness rate if confirmed, could be blamed on low detection activity and accordingly non-optimal performance of the National strategy. It is also possible that many participants already diagnosed with hypertension, and perhaps on treatment and controlled on such treatment, did not feel the need to attend the screening campaign again. This would have the undesirable effect of biasing our estimates by providing much lower than the true figures. It is also possible that those with known and treated condition instead turned out in higher number to use the campaign as an opportunity for their health checkup free of charge. Our stratified analyses suggest that this mix could vary substantially by participating centers. -In general however, low awareness of hypertension has been reported as a global phenomenon,[27] although the magnitude may be less important in the developed world[23 28]. In the USA for instance, awareness of hypertension is as higher as 76%,[28] reflecting the success achieved by a coordinated policy to detect individuals with higher-than-optimal blood pressure levels.

The low treatment and control rates in our study reflect the interplay between many factors which were not directly captured by the current study. These include both patient-level, healthcare provider level and health system level factors. Indeed, patients are expected to be treated and controlled only if they can access appropriate health services, receive adequate advice and prescriptions, and subsequently afford and adhere to those prescriptions. Accessibility to health care facility has likely improved in urban settings in Cameroon in recent years. However the physician-to-population ratio, just like in many other countries in the region, is still very low[29] and may explain the low awareness and treatment gaps. Affordability of the cost of care also remains a major barrier in the study setting where out-of-pocket spending is the main source of funding for healthcare costs. Adherence to prescribed medications is another patient-level determinant of risk factor control not investigated in the

present study. Studies in Africa have shown that non-adherence to treatment and follow-up for hypertension was very common.[30-32] In one intervention study in Cameroon for instance, just about half of participants were still in the programme at 1-year of follow-up.[31]

Potential limitations and strengths of our study

The present study has some limitations. Participants were self-selected and may therefore not necessarily be representative of the general population in participating cities. Access to mass media (radio and television) is almost universal in major cities in the countries, and there is therefore no suggestion that advertisement of the campaign would have selectively reached certain portions of the population. It remains however; that participants in the study could still differ from the general population by being more or less health conscious, and having less severe disease for example, which could affect some parameters in the study. The study used a cross-sectional design, which precludes any causality inference. Diagnosis of hypertension was based on blood pressure measurements during a single encounter, which is at variant with guidelines recommendations for hypertension diagnosis using two measurements recorded on three separate occasions.[17] This may have overestimated the prevalence of hypertension and underestimated the level of blood pressure control. This however, would not affect comparisons with previous epidemiological studies that have used similar measurement methodology. Diagnosis of hypertension among those with no history of hypertension in our study was based on a single blood pressure measurement. Our sensitivity analysis suggests that this approach could inflated the crude prevalence by about 5.4% and 4.6% among those not known to have hypertension prior to the survey and at the total population level respectively. Nevertheless, even after accounting for this possible effect, our estimates would still be within sampling variation of the figures previously reported in this setting. It is also of note that no participant received a definitive diagnosis of hypertension as the result of taking part in this study. Those with elevated blood pressure levels were instead referred to health

care facilities for further evaluation. The strengths of this study include the large sample of the general population and, the rigorous collection of various lifestyle factors, medical data and blood pressure measurements by trained staff according to standardized protocols, the adequate standardization of prevalence and allowing comparisons with other African countries. In addition, our sampling approach provides evidence that simple announcements through mass media can attract from the community a large number of individual at risk of undiagnosed hypertension.

Conclusions

In conclusion, our study ~~confirms~~ provides findings suggesting the high prevalence of hypertension previously reported in urban settings in Africa. Detection, treatment and control efforts are likely still well below optimal. This raises serious concerns about the prospects of having to care very soon for both patients with higher-than-optimal blood pressure and many more with target organ lesions subsequent to longstanding hypertension. There are already some indications that the burden of stroke, end-stage renal disease and heart failure related to hypertension is growing in the country and the region.[2 6 33]

Perspectives

The low awareness, treatment and control rates of hypertension in this potentially health conscious urban sub-Saharan population invite innovative approaches to improve prevention, detection, treatment of hypertension beyond the traditional healthcare facilities based approaches which are currently in force in many countries in the region.

Declaration of competing interest. None for all authors.

Author contribution. Dzudie and Kengne had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Dzudie, Kengne, Muna, Ngu, Kingue.

Acquisition of data: Ba, Menanga, Kouam Kouam, Abah, Monkam, Biholong, Mintom, Kamdem, Djomou, Njebet, Ouambo, Luma,

Analysis and interpretation: Dzudie, Kengne, Muna

Drafting of the manuscript: Dzudie, Kengne, Muna

Critical revision of the manuscript for important intellectual content: all co-authors

Acknowledgements

The authors would like to express their gratitude to the following bodies and individuals for their contribution to the success of this study: 1) The Cameroon Ministry of public health for providing the blood pressure devices and health staff; 2) The executive committee and members of the Cameroon Cardiac Society for their support for data collection; 3) Servier Pharma Cameroon for a financial contribution to support data processing and drafting of the manuscript; 4) All specialist physicians, enthusiastic general practitioners, medical students and nurses involved in data collection; and 5) All those who helped at the different stages of the project and the fellow Cameroonians who volunteered across the four participating cities to take part in the study.

Data sharing statement: No additional data available

Appendix 1

Cameroon Cardiac Society (CCS) investigators group:

(1) Douala: Anastase Dzudie, Hamadou Ba, Henri Roger Ngote, Christian Biholong, Félicité Kamdem, Armel Djomou, Jules Njebet, Cyrille Ouambo, Roger Mboulley Kotto, Barbara Bouellet Abeng, Marielle Epacka Ewane Lobe and Yves Monkam.

(2) Yaounde : Alain Menanga, Pierre Mintom, Euloge Yiagnigni, Mérimée Ouankou, Christophe Nouedoui, Pierre Ndobo, Marie Ntep, Monique Kenfack, Sylvie Ndongo, Martine Tchuem, Edvine Wawo, Walinjom F.T. Muna, Katleen Ngu Blackett and Samuel Kingue.

(3) Bafoussam: Charles Kouam Kouam

(4) Bamenda: Joseph Abah.

References

1. Kearney PM, Whelton M, Reynolds K, et al. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005;365:217-23.

2. Kengne AP, Anderson CS. The neglected burden of stroke in Sub-Saharan Africa. *Int J Stroke* 2006;1:180-90.

3. Addo J, Smeeth L, Leon DA. Hypertension in sub-saharan Africa: a systematic review. *Hypertension* 2007;50:1012-8.

4. Kengne AP, Amoah AG, Mbanya JC. Cardiovascular complications of diabetes mellitus in sub-Saharan Africa. *Circulation* 2005;112:3592-601.

5. Damasceno A, Cotter G, Dzudie A, et al. Heart failure in sub-saharan Africa: time for action. *J Am Coll Cardiol* 2007;50:1688-93.

6. Kengne AP, Awah PK. Classical cardiovascular risk factors and all-cause mortality in rural Cameroon. *Qjm* 2009:doi:10.1093/qjmed/hcn175.

7. Fezeu L, Kengne AP, Balkau B, et al. Ten-year change in blood pressure levels and prevalence of hypertension in urban and rural Cameroon. *J Epidemiol Community Health* 2010;64:360-5.

8. Turnbull F. Effects of different blood-pressure-lowering regimens on major cardiovascular events: results of prospectively-designed overviews of randomised trials. *Lancet* 2003;362:1527-35.

9. Kamadjeu RM, Edwards R, Atanga JS, et al. Prevalence, awareness and management of hypertension in Cameroon: findings of the 2003 Cameroon Burden of Diabetes Baseline Survey. *J Hum Hypertens* 2006;20:91-2.

10. Leon DA. Cities, urbanization and health. *Int J Epidemiol* 2008;37:4-8.

11. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr* 2006;84:289-98.

12. de-Graft Aikins A, Unwin N, Agyemang C, et al. Tackling Africa's chronic disease burden: from the local to the global. *Globalization and health* 2010;6:5.

13. Lekoubou A, Awah P, Fezeu L, et al. Hypertension, diabetes mellitus and task shifting in their management in sub-Saharan Africa. *Int J Environ Res Public Health* 2010;7:353-63.

14. Cameroon's National Institute of Statistics. Statistical Yearbook 2010, 2011:39-52.

15. Cameroon's National Institute of Statistics. Population du Cameroun en 2010, 2011.

16. Woodward M, editor. *Epidemiology: study design and data analysis*. Second ed. New York: Chapman & Hall/CRC, 2005.

17. Mancia G, De Backer G, Dominiczak A, et al. 2007 Guidelines for the Management of Arterial Hypertension: The Task Force for the Management of Arterial Hypertension

of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2007;25:1105-87.

18. Kengne AP, Awah KP, Fezeu L, et al. The burden of high blood pressure and related risk factors in urban sub-Saharan Africa: Evidences from Douala in Cameroon. *African Health Sciences* 2007;7:38-44.
19. Danaei G, Finucane MM, Lin JK, et al. National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5.4 million participants. *Lancet* 2011;377:568-77.
20. Jenson A, Omar AL, Omar MA, et al. Assessment of hypertension control in a district of Mombasa, Kenya. *Glob Public Health* 2011;6:293-306.
21. Ulasi, II, Ijoma CK, Onodugo OD. A community-based study of hypertension and cardio-metabolic syndrome in semi-urban and rural communities in Nigeria. *BMC Health Serv Res* 2010;10:71.
22. Damasceno A, Azevedo A, Silva-Matos C, et al. Hypertension prevalence, awareness, treatment, and control in mozambique: urban/rural gap during epidemiological transition. *Hypertension* 2009;54:77-83.
23. Wagner A, Sadoun A, Dallongeville J, et al. High blood pressure prevalence and control in a middle-aged French population and their associated factors: the MONA LISA study. *J Hypertens* 2011;29:43-50.
24. Wolf-Maier K, Cooper RS, Banegas JR, et al. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. *Jama* 2003;289:2363-9.
25. Njamnshi AK, Bella Hiag A, Mbanya JC. From research to policy: the development of a national diabetes programme in Cameroon. *Diabetes Voice* 2006;55:18-21.

26. Kengne AP, Sobngwi E, Fezeu L, et al. Setting-up nurse-led pilot clinics for the management of non-communicable diseases at primary health care level in resource-limited settings of Africa *PAMJ* 2009;3:10.

27. Marques-Vidal P, Tuomilehto J. Hypertension awareness, treatment and control in the community: is the 'rule of halves' still valid? *J Hum Hypertens* 1997;11:213-20.

28. Cheung BM, Ong KL, Man YB, et al. Prevalence, awareness, treatment, and control of hypertension: United States National Health and Nutrition Examination Survey 2001-2002. *J Clin Hypertens (Greenwich)* 2006;8:93-8.

29. World Health Organisation. Task shifting to tackle health worker shortage. Geneva, 2007.

30. Kengne AP, Awah PK, Fezeu LL, et al. Primary health care for hypertension by nurses in rural and urban sub-Saharan Africa. *J Clin Hypertens (Greenwich)* 2009;11:564-72.

31. Labhardt ND, Balo JR, Ndam M, et al. Improved retention rates with low-cost interventions in hypertension and diabetes management in a rural African environment of nurse-led care: a cluster-randomised trial. *Trop Med Int Health* 2011.

32. Dennison CR, Peer N, Steyn K, et al. Determinants of hypertension care and control among peri-urban Black South Africans: the HiHi study. *Ethn Dis* 2007;17:484-91.

33. Halle MP, Kengne AP, Ashuntantang G. Referral of patients with kidney impairment for specialist care in a developing country of sub-Saharan Africa. *Ren Fail* 2009;31:341-8.

Legend for figures and tables

Figure 1: Mean systolic and diastolic blood pressure by age groups for men (left panel) and women (right panel).

Figure 2 – Blood pressure control among participants with hypertension according to the number of cardiovascular risk factors.

Risk factors considered were: overweight or obesity, high waist, current or past smoking, physical inactivity, diagnosed diabetes, dyslipidemia. None of the 116 participants with none of the risk factor had hypertension.

Table 1 - General characteristics of the study population overall and by Region

Characteristic	Regions									p region	Overall		
	Centre			Littoral			North-West and West						
	Men	Women	P	Men	Women	P	Men	Women	p		Men	Women	p
N	376	273		609	558		132	172		<0.001	1117	1003	
Mean age, yrs. (SD)	41 (12)	42 (14)	0.43	45 (13)	43 (14)	0.33	48 (14)	45 (14)	0.08	<0.001	44 (13)	43 (14)	0.19
Age groups, n			0.26			0.006			0.22	<0.001			0.01
<35 years	134	97		145	180		23	44			302	321	
35-44 years	99	57		154	108		32	40			285	205	
45-54 years	86	65		163	139		34	47			284	251	
≥55 years	57	54		146	131		43	41			246	226	
Mean BMI, kg/m^2 (SD)	26.2 (4.0)	27.2 (4.5)	0.002	26.9 (4.8)	29.0 (6.3)	<0.001	27.6 (5.0)	29.3 (5.4)	0.006	<0.001	26.7 (4.6)	28.6 (5.8)	<0.001
Waist girth, cm (SD)	96 (13)	94 (12)	0.04	91 (13)	91 (15)	0.31	95 (12)	97 (12)	0.15	<0.001	93 (13)	93 (14)	0.80
Mean SBP, mmHg (SD)	133 (22)	129 (24)	0.06	142 (26)	139 (30)	0.05	136 (25)	125 (25)	<0.001	<0.001	139 (25)	134 (28)	<0.001
Mean DBP, mmHg (SD)	77 (17)	77 (16)	0.98	85 (17)	82 (18)	0.001	85 (15)	79 (15)	0.001	<0.001	83 (17)	80 (17)	0.001
Parental hypertension, n	77	77	0.02	158	191	0.002	38	55	0.62	0.01	273	323	<0.001
History of diabetes, n	27	27	0.22	27	31	0.42	21	31	0.65	<0.001	75	89	0.07
History of dyslipidemia, n	1	0	>0.99	4	9	0.16	0	0	N/A	0.005	5	9	0.28
History of gout, n	0	1	0.42	13	9	0.53	1	0	0.43	<0.001	14	10	0.68
Physical activity, n	160	86	0.004	334	180	<0.001	82	104	0.77	<0.001	576	370	<0.001
Smoking, n			<0.001			<0.001			<0.001	0.07			<0.001
Never	320	267		500	540		113	170			933	977	
Former	21	26		43	7		4	0			68	12	
Current	35	36		66	11		15	2			116	14	
Excessive alcohol, n	85	17	<0.001	147	51	<0.001	51	32	<0.001	<0.001	283	100	<0.001

BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; SD, standard deviation

Table 2 - Hypertension prevalence, awareness and control among self-selected urban dwellers in Cameroon

Gender Region	Variable	Overall	Overall*	Age groups (years)				P-trend
				<35	35-44	45-54	≥55	
Centre	Prevalence (%)	35.4	27.3 (23.3-31.3)	15.1	28.2	48.3	70.3	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	230	230	35	44	73	78	
	Awareness (%)	30.4	12.5 (9.3-15.7)	0	22.7	31.5	47.4	<0.001
	Among hypertensives (n)	70	70	0	10	23	37	
	Treatment (%)	61.4	21.9 (13.6-30.2)	NA	50.0	52.2	70.3	0.13
	Among aware hypertensives (n)	43	43	NA	5	12	26	
	Control A (%)	25.6	6.7 (2.5-10.9)	NA	0	33.3	26.9	0.41
	Among treated hypertensive (n)	11	11	NA	0	4	7	
	Control B (%)	25.6	6.7 (2.5-10.9)	NA	0	33.3	26.9	0.41
	Among treated hypertensive (n)	11	11	NA	0	4	7	
Littoral	Prevalence (%)	53.6	43.6 (39.2-48.0)	33.8	45.0	61.7	76.2	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	626	626	110	118	187	211	
	Awareness (%)	25.1	15.1 (11.3-18.9)	9.1	11.9	25.1	40.8	<0.001
	Among hypertensives (n)	157	157	10	14	47	86	
	Treatment (%)	49.0	38.7 (16.7-60.7)	30.0	57.1	46.8	51.2	0.42
	Among aware hypertensives (n)	77	77	3	8	22	44	
	Control A (%)	18.2	26.8 (-13.7 to 67.3)	33.3	12.5	22.7	15.9	0.60
	Among treated hypertensive (n)	14	14	1	1	5	7	
	Control B (%)	18.2	26.8 (-13.7 to 67.3)	33.3	12.5	22.7	15.9	0.60
	Among treated hypertensive (n)	14	14	1	1	5	7	
Others	Prevalence (%)	49.7	34.4 (26.6-42.2)	22.4	30.6	51.8	85.7	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	151	151	15	22	42	72	
	Awareness (%)	60.9	30.3 (17.7-42.9)	13.3	40.9	53.5	77.8	<0.001
	Among hypertensives (n)	92	92	2	9	25	56	
	Treatment (%)	77.7	91.6 (5.6-178)	100	77.8	84.0	73.2	0.30
	Among aware hypertensives	71	71	2	7	21	41	
	Control A (%)	31.0	12.9 (4.7-21.1)	0	42.9	14.3	39.0	0.22
	Among treated hypertensive (n)	22	22	0	3	3	16	
	Control B (%)	56.3	51.5 (-9.7 to 113)	50.0	57.1	33.3	68.3	0.12
	Among treated hypertensive (n)	40	40	1	4	7	28	
Men	Prevalence (%)	50.1	41.3 (36.9-45.7)	31.7	38.9	57.2	77.6	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	560	560	96	111	162	191	
	Awareness (%)	24.6	13.5 (10.0-17.0)	6.3	12.6	21.6	43.5	<0.001
	Among hypertensives (n)	138	138	6	14	35	83	
	Treatment (%)	57.9	54.6 (19.3-89.9)	50	64.2	65.7	54.2	0.53
	Among aware hypertensives	80	80	3	9	23	45	
	Control A (%)	18.8	28.2 (-12.0 to 68.6)	33.3	22.2	21.7	15.5	0.36
	Among treated hypertensive (n)	15	15	1	2	5	7	
	Control B (%)	27.5	50.3 (-6.3 to 107)	66.6	22.2	26.1	26.7	0.49
	Among treated hypertensive (n)	22	22	2	2	6	12	
Women	Prevalence (%)	44.6	32.5 (28.8-36.2)	20.2	35.6	55.8	75.2	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	447	447	64	73	140	170	
	Awareness (%)	40.5	20.9 (15.6-26.2)	9.3	26.0	42.8	54.5	<0.001
	Among hypertensives (n)	181	181	6	19	60	96	
	Treatment (%)	61.3	43.3 (13.9-72.7)	33.3	57.9	53.3	68.9	0.03
	Among aware hypertensives	111	111	2	11	32	66	
	Control A (%)	28.8	8.0 (4.6-13.8)	0	18.1	21.8	34.8	0.08
	Among treated hypertensive (n)	32	32	0	2	7	23	
	Control B (%)	38.7	12.8 (7.2-18.4)	0	2.7	31.3	45.5	0.06
	Among treated hypertensive (n)	43	43	0	3	10	30	

Data are percentages with numerators below. Control A, blood pressure below 140/90 mmHg or 130/80 mmHg among diabetic patients; Control B, blood pressure below 140/90 mmHg among all ~~subjects~~participants. DBP, diastolic blood pressure; NA, not applicable SBP, systolic blood pressure.

* Age standardized according to the 2010 Cameroon national population distribution.

Table 3 - Crude and adjusted odds ratios for predictors of hypertension among self-selected urban dwellers in Cameroon.

Variable	Category	Unadjusted odd ratios (95% CI)	p	Adjusted odd ratios (95% CI)*	p
Sex	Men	1.25 (1.05-1.48)	0.01	1.63 (1.34-2.00)	<0.001
Age	<35 years	1 (reference)	<0.001	1 (Reference)	<0.001
	35-44 yrs	1.74 (1.35-2.25)		1.32 (1.01-1.73)	
	45-54 yrs	3.75 (2.93-4.81)		2.81 (2.16-3.64)	
	≥55 yrs	9.41 (7.12-12.43)		8.27 (6.19-11.04)	
Region	Centre	1 (Reference)	<0.001	1 (Reference)	<0.001
	Littoral	2.11 (1.73-2.57)		1.89 (1.52-2.36)	
	Others	1.80 (1.36-2.37)		1.38 (1.01-1.89)	
Parental hypertension	Yes	1.47 (1.21-1.77)	<0.001	1.55(1.25-1.92)	<0.001
Diabetes mellitus	Yes	3.77 (2.61-5.44)	<0.001	2.63 (1.75-3.94)	<0.001
Dyslipidemia	Yes	2.00 (0.67-5.98)	0.22	1.55 (0.47-5.11)	0.47
Gout	Yes	3.36 (1.33-8.49)	0.01	1.70 (0.62-4.67)	0.30
Smoking	Never	1 (Reference)	0.11	1 (Reference)	0.62
	Former	1.59 (1.01-2.51)		0.96 (0.59-1.65)	
	Current	0.90 (0.63-1.29)		0.82 (0.54-1.22)	
Physical activity	No	0.90 (0.76-1.07)	0.23	1.13 (0.93-1.38)	0.21
Excessive alcohol	Yes	1.33 (1.06-1.66)	0.01	1.05 (0.81-1.36)	0.70
Body mass index	Normal	1 (Reference)	<0.001	1 (Reference)	<0.001
	Overweight	2.03 (1.65-2.50)		1.94 (1.54-2.45)	
	Obese	3.54 (2.83-4.43)		3.32 (2.57-4.29)	
High waist girth		2.12 (1.78-2.52)	<0.001	1.94 (1.51-2.48)	<0.001

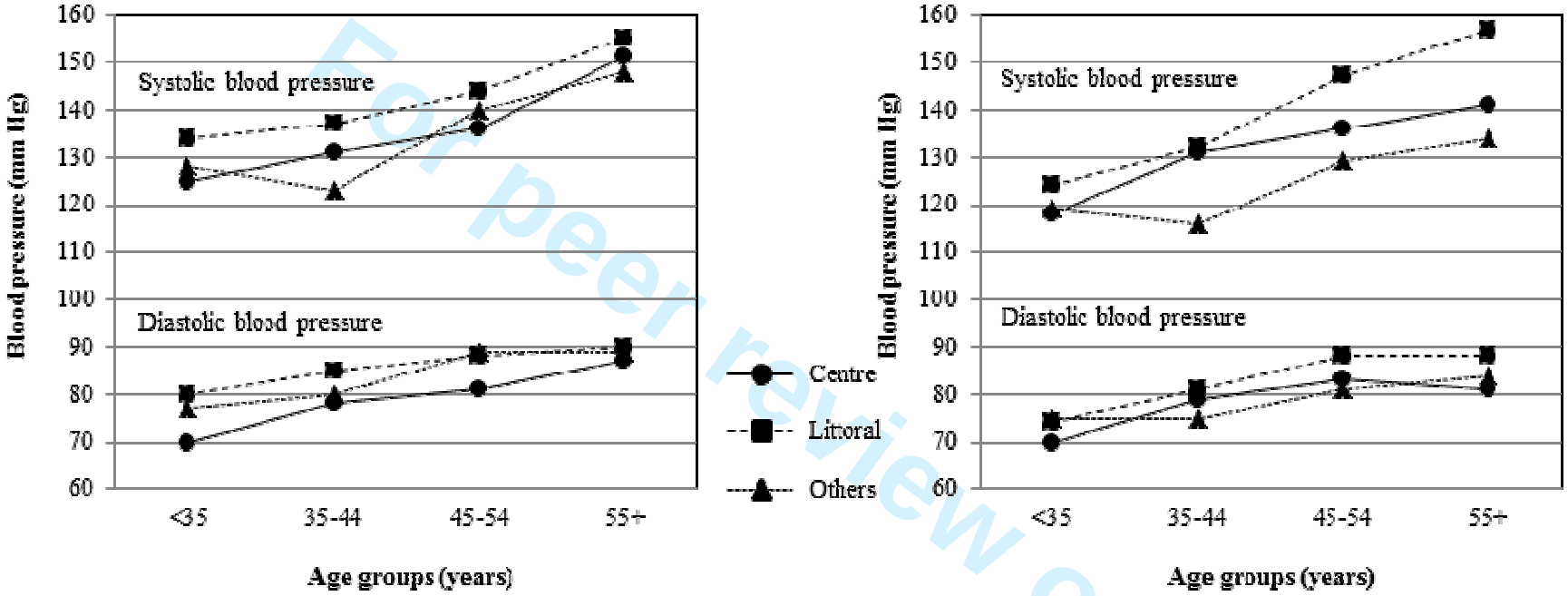
* age, sex, parental history of hypertension, body mass index and region adjusted; CI, confidence interval

Table 4 - Crude and adjusted odds ratios for predictors of hypertension control among self-selected and treated hypertensives in four main cities of Cameroon.

Variable	Category (%)	Unadjusted odd ratios (95% CI)	P	Adjusted odd ratios (95% CI)*	p
Sex	Men	059 (0.35-1.00)	0.05	0.47 (0.26-0.86)	0.01
Age	<35 years	1.00 (Reference)	0.87	1.00 (Reference)	0.63
	35-44 yrs	0.54 (0.12-2.32)		0.38 (0.07-1.99)	
	45-54 yrs	0.68 (0.19-2.45)		0.57 (0.13-2.41)	
	≥55 yrs	0.67 (0.19-2.34)		0.46 (0.11-1.88)	
Region	Centre	1.00 (Reference)	<0.001	1.00 (Reference)	<0.001
	Littoral	0.72 (0.35-1.50)		0.70 (0.33-1.52)	
	Others	3.36 (1.64-6.87)		3.50 (1.65-7.42)	
Parental hypertension	Yes	1.44 (0.87-2.40)	0.16	1.56 (0.89-2.75)	
Diabetes mellitus	Yes	2.73 (1.60-4.67)	<0.001	1.83 (0.98-3.39)	0.06
Dyslipidemia	Yes	0.74 (0.08-6.75)	0.79	1.30 (0.13-13.26)	0.83
Gout	Yes	NA (None)			
Smoking	Never	1.00 (Reference)	0.53	1.00 (Reference)	0.72
	Former	0.79 (0.21-2.89)		1.26 (0.30-5.34)	
	Current	0.32 (0.04-2.57)		0.44 (0.05-3.97)	
Physical activity	No	0.30 (0.17-0.56)	<0.001	0.36 (0.20-0.66)	0.001
Excessive alcohol	Yes	0.59 (0.26-1.32)	0.20	0.64 (0.26-1.60)	0.34
Body mass index	Normal	1.00 (Reference)	0.002	1.00 (Reference)	0.003
	Overweight	0.41 (0.22-0.77)		0.44 (0.22-90)	
	Obese	0.34 (0.18-0.66)		0.28 (0.14-0.59)	
High waist girth		0.86 (0.51-1.44)	0.56	0.77 (0.33-1.77)	0.54

* age, sex, parental history of hypertension, body mass index and region adjusted; CI, confidence interval.

Figure 1:



Manuscript ID bmjopen-2012-001217 entitled "Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Dear Editor,

We are grateful to the reviewers for their time and very constructive comments on our manuscript.

We have used those comments to improve our work and wish to submit an updated version for further consideration for publication in the Journal.

In particular, to overcome the issue of single BP measurement, we now report sensitivity analyses based on data for nearly 80% of those diagnosed with hypertension based on a single measurement, and who also had a second BP measurement on the same day. The results based on the average of two BP measurements do not support a massive inflation of our results. Similarly, we also provide more stratified results by city now.

Changes in the new version of the manuscript appear with the tack changes indication or red colour in tables.

We also provide a point-by-point response to each comment from the reviewer. Each time our response includes material from the manuscript, it is indicated in *italic* and **in black** colour if such a material was already present in the original version of the manuscript or in **red colour** for new material.

We look forward to the outcome of your assessment.

Yours sincerely,
Andre Pascal Kengne
On behalf of the co-authors

Reviewer(s)' Comments to Author:

Reviewer: Dr Juliet Addo
Lecturer, London School of Hygiene and Tropical Medicine, UK

The participants included in the study are not representative of the general Cameroon population as they were self-selected. The authors have however acknowledged this as a limitation of the study.

This paper addresses an important health problem in sub Saharan Africa (SSA) where previous studies have highlighted the high prevalence of hypertension particularly in urban areas. It is well written and adds to the available evidence from the sub region. There are however a few issues that require addressing or clarification.
The authors state the aims clearly including assessing the variability of the prevalence and determinants by region and gender which is clearly an interesting aspect of this paper particularly if there are significant differences between these regions in terms of perhaps level of urbanisation or occupation. This information is not clearly given and the prevalence, awareness, control etc is not reported by the regions except for the graph showing the mean blood pressure readings. I am also not certain why there were such differences in the number reporting from each of the cities sampled.

Our response: Thank you for raising this point. We have addressed the issue by updating the former Table 3 (now Table 2) to introduce region-specific data, in addition to those on gender. The result section has also been updated to reflect this change.
Differences in the number of participants across regions likely reflect differences in the sizes of the background population of the participating cities. For instance Yaounde (Centre region) and Douala (Littoral region) have got population sizes in the region of 1.3 to 1.5 million, while Bafoussam (West region) and Bamenda (North-West region) have less than 0.5 million population each.

The method of recruitment which was by self-selection could potentially have biased the participation and over-estimated the prevalence of hypertension as was discussed by the authors. Could this have affected the response to the survey from particular cities more than others?

Our response: Analyses stratified by region (Table 2 and 3) suggest that participants from regions other than Centre and Littoral likely included relatively more participants who were aware of their status for hypertension, and likely receiving treatment. However, the relatively small number of participants from those regions would not significantly affect the overall results.

The authors do state the measurement of blood pressure on one visit only as a limitation. This is clearly important. In most similar studies several readings of blood pressure have been taken on the same day where it was not possible to arrange for a repeat visit and the average of two or three readings determined. There is however no reporting of this being done in this study where it appears only one measurement was taken.

Our response: Based on the predefined protocol of the survey and to limit the workload for the staff (given the limited staff number) and waiting time for participants, only those

participants with an abnormal first reading were requested to have a second BP measurement. Even on such a protocol, some participants with raised BP left without having their second BP measured, and few other second measurements failed to be reported in some participants. Overall, of the 688 participants not know to suffer from hypertension and who had a raised BP (SBP/DBP>=140/90) based on the first measurement, a second valid measurement was available for 537 (78%). We have now repeated the analysis and found that among the 537, 85.8% (462 participants) had raised BP based on the average of the two measurements. This at the population level will translate into about 5% point overestimation of the prevalence of new hypertension based on a single measurement. We have added this new information as a sensitivity analysis indicated both in the methods, results and discussion chapters. The relevant sections read:

In the method section:

"Sensitivity analysis

The main analyses were based on a single blood pressure measurement. To assess the potential effects of 'regression to the mean' phenomenon on the prevalence of hypertension, a sensitivity analysis was conducted among participants with a raised initial blood pressure (SBP/DBP>=140/80 mmHg) and who had their blood pressure taken a second time on the same day. This analysis was based on the average of the first and second measurements."

In the result section

"Sensitivity analysis

Among participants with newly diagnosed hypertension based on the first blood pressure measurement (688 participants), 537 (78.0%) had a valid second measurement. Their mean blood pressure (SD) was 159.4 (19.0) for systolic and 94.4 (14.2) mmHg for diastolic based on the first measurement. Equivalents were 154.5 (19.0) and 93.0 (13.1) mmHg based on the average of the two measurements. Of the 537 participants 461 (85.8%) had hypertension (systolic/diastolic blood pressure>=140/90 mmHg) using the average of the two blood pressure measurements."

In the discussion, under the limitation section

"*Diagnosis of hypertension among those with no history of hypertension in our study was based on a single blood pressure measurement. Our sensitivity analysis suggests that this approach could inflated the crude prevalence by about 5.4% and 4.6% among those not known to have hypertension prior to the survey and at the total population level respectively. Nevertheless, even after accounting for this possible effect, our estimates would still be within sampling variation of the figures previously reported in this setting. It is also of note that no participant received a definitive diagnosis of hypertension as the result of taking part in this study. Those with elevated blood pressure levels were instead referred to health care facilities for further evaluation.*"

Was there a measure of socioeconomic status such as level of education or wealth and could this be a predictor of hypertension prevalence and control?

Our response: Unfortunately, we did not collect data on these important predictors.

The authors did not state that they aimed to determine the level of hypertension control according to the number of risk factors and so I am uncertain what Figure 2 adds to the study. Was the plan to study total cardiovascular risk as well? Table 2 also reporting on blood pressure categories in participants could also be presented by a few sentences in the results section.
The manuscript could therefore be shortened considerably.

Our response: We have now removed the table 2 and kept only the narrative summary in the results section. We have also removed the Figure 2 and all reference to that figure as well.

Minor comment is to stick to the term participants instead of subjects.

Our response: We now use 'participants' throughout

Overall, this paper adds to the literature that reflects the lack of awareness, treatment and control of hypertension in SSA and highlights the need for addressing these effectively.

Our response: Thank you for the appreciation

Reviewer: Dr Niklaus Daniel Labhardt, MD MIH SolidarMed Seboche Hospital Botha-Bothe Lesotho

I have no conflicts of interest to be declared

Overall Study Design:
The authors state, the objective is to "quantify the burden ... of hypertension, treatment and control rates among adults in major cities in Cameroon". These objectives can not be answered by the study design applied in this paper for two reasons:

1. To assess the burden, treatment and control rates among adults in urban Cameroon, one should use another sampling method than the one used in the study. This study used persons who attended by their own motivation a screening campaign. The study sample can therefore not be considered as being representative and therefore not provides information about the overall burden and control-rates in urban Cameroon.
2. A single BP-measurement per individual is not reliable. It may lead to a substantial overestimation of the prevalence. (see: Bovet, P., Gervasoni, J.P., Ross, A.G., Mkamba, M., Mtasiwa, D.M., Lengeler, C., Burnier, M. & Paccaud, F., 2003, Assessing the prevalence of hypertension in populations: are we doing it right? Journal of hypertension, 21(3), pp. 509-17.)

The two limitations are acknowledged under limitations. However, the first one is not a limitation. In my view it is a recruitment bias.

Our answer: Thank you for raising these points, which as recognised by the reviewer have been highlighted in the limitation section of the manuscript. We feel that both are potential sources of biases ('selection bias' for the 1st and 'regression to the mean' for the second). We

feel that the 'limitation section' of the article is the place where all issues from the study conception through to data analysis and reporting, that can potentially affect the internal and or external validity of the study are acknowledged.

With regard to point 1, we have made no claim that our sample was representative of the background Cameroonian population in participating cities, and would refrain from doing so. We have rather discussed extensively on those factors that could potentially make our sample to be different from the background population. The most we could do was to attempt to control some of the possible biases that could result from our sampling approach; through reporting of the age and standardised estimates for instance. We now even provide those standardised estimates by participating city. We also have to acknowledge the challenges of conducting a representative population-based survey in a country where no household numbering has been implemented, and with virtually no funding as done for the current study. In such a context, previous studies have been conducted by selecting for instance a suburb in a given city (supposedly representative of the population of the city), then enumerating the household to allow a random sample. That our results are in major ways similar to those from those from those studies perhaps suggests that the two approaches have possibly captured the same characteristics in the population. Therefore, our results have utility in the context of those available.

With regard to point 2, please see our answer to reviewer #1 on the further steps we have undertaken to quantify the possible magnitude of the overestimation induced by our reliance on a single BP measurement. Our sensitivity analyses suggest that the approach could have inflated the crude prevalence by about 5% point. Even accounting for such an effect the prevalence would still be high, reflecting the background high prevalence reported in previous studies. We do however recognised that this may not be the more appropriate approach for assessing BP levels in surveys and have again emphasized it in the limitation section.

Overall English is good. However, some of the wording may be checked again.

Our answer: We have checked the manuscript again and fixed those wording issues identified.

DISCUSSION:
The subsection on prevalence of hypertension should be reviewed. I think the present study cannot add any evidence to prevalence in the Cameroon population (see above).
The subsection on awareness should equally be reviewed based on the same problem of self-selection.

Our answer: Thank you for raising this point. We have now removed the claim that our study updates the prevalence of hypertension in country. We however feel that it is still important to cautiously discuss our findings in the context of available data, as this provide of opportunity of speculating on the possible biases introduced by the methodological limitations discussed above.

CONCLUSION:

The conclusion "In conclusion, our study confirms the high prevalence of hypertension previously reported in urban settings in Africa. Detection, treatment and control efforts are still well below optimal." cannot be made based on this study (see above).

Our answer: We have changed the wording. It now reads:

"*In conclusion, our study provides findings suggesting the high prevalence of hypertension previously reported in urban settings in Africa. Detection, treatment and control efforts are likely still well below optimal."*

In general the paper is very well written, statistical methods are appropriate and the results are well presented. However, I think due to the selection bias, the study does not answer its major objective. The subsequent detailed analyses about predictors of hypertension in this specific population are indeed correct. However, it is nothing new and as a considerable number of the individuals diagnosed being hypertensive in this study may in reality be normotensive, the usefulness of these analyses are questionable to me.
I fully acknowledge the importance of hypertension in sub-Saharan Africa and basically any publication about this topic is welcome. However, I doubt if the findings of this study really contribute to our knowledge due to the selection bias and the one single-reading procedure. I would recommend to shorten the manuscript considerably and to resubmit it as a brief report or short communication, summarizing the findings from screening campaigns in 3 different urban settings in Cameroon. (MANAGING EDITOR'S NOTE - please note BMJ Open does not publish short reports; if you wish to do this you will need to submit elsewhere)

Our answer: We thank the reviewer for his appreciation. We are well aware of the potential effects of the issues raised on our findings and have discussed them at length in the manuscript. We remain however of those who believe that 'the perfect' shouldn't be the enemy of 'the possible' and would prefer to strive with the little means available to us, to generate any evidence that can potentially inform health service and policy solutions. We also believe that keeping a full paper aid the provision of detailed information with potential utility locally and even beyond.

Reviewer: Albertino Damasceno
Professor of Cardiology, Eduardo Mondlane University Maputo, Mozambique

I have no conflit of interests.

This interesting study that evaluated hypertension and other cardiovascular risk factors in a large population and in 4 different cities has in our opinion two major problems.
The sample used to evaluate the prevalence of hypertension was based on a group of self-selected adults that voluntary came to be evaluated. Although some recent papers have been published using the same methodology, this should be not accepted as a standard epidemiological methodology. With this sample it is not possible to generalize the results neither to the urban population of Cameroon nor to the national population.
This can be clearly seen in the large differences of people that was observed in the 4 different cities – a very small group of people observed in 2 regions in the West and North West regions (304 - 14.3%) compared with a large group that came in the littoral (1167 - 54.1%). This turns any comparison among regions very unlikely.

Our response: Thank you for the appreciation and for raising this point which we have addressed already above (see our answer to reviewer #1). There are true differences in the population size of the participating cities, with Douala and Yaounde being much larger than Bafoussam and Bamenda. Everything else being equal, one would expect fewer participants from the latters, which is been reflected in the turn out numbers by city in our study.

Another way to see that the sample is not a representative one is the division of the participants by age groups. While in the Center city the younger group in the largest and the older the smaller as expected in the other 3 regions the sample shows the contrary with the older being more common than the younger denoting a non-representative sample of the population.

Our response: We have attempted to address this point now by providing age standardised prevalence by participating city. Please see the new table 2 in the main manuscript.

Big differences between the mean systolic and diastolic blood pressures of the center city and the other ones are shown as well as very big differences in the prevalence of self-reported diabetes in men between the Center city (about 4%) and the West and North west cities (about 16%). In our opinion, if not explained, this reflects the bias in the selection of the participants.

Our response: We now report the age-standardised prevalence by participating centres, which suggest differences by city in prevalence, awareness and treatment. In the absence of specific data on the background access to hypertension diagnosis and care by city, it is very difficult to speculate on the likely direction of the effect of possible bias if any. We have however provided the following points in the discussion.

"*It is also possible that many participants already diagnosed with hypertension, and perhaps on treatment and controlled on such treatment, did not feel the need to attend the screening campaign again. This would have the undesirable effect of biasing our estimates by providing much lower than the true figures. It is also possible that those with known and treated condition instead turned out in higher number to use the campaign as an opportunity for their health checkup free of charge. Our stratified analyses suggest that this mix could vary substantially by participating centers."*

The second problem that is not clear in the methodology is how was the blood pressure measured? The value of the blood pressure used to classify these adults as hypertensive/normotensive patients is the result of a single measurement or the mean of several measurements? The measurement during a single encounter was already used in several epidemiological studies and is the methodology proposed by WHO in the STEP wise approach but this value should be the mean of 3 consecutive measurements. The authors do not specify how many measurements have done in each participant. If only one measurement was done, like is understandable in the methodology of the paper, the discriminative power of this single measurement is very poor and this should be clearly stress in the methodology and the discussion.

Our response: Please refer to our answer to reviewer 1 on this point above.

Just three other small remarks:

Line 18 on page 8 >94 in men and >80 in women

Our response: This was based on the IDF definition of metabolic syndrome.

Alcohol consumption was done using just beer or wine consumption. Was the consumption of traditional alcoholic beverages or whisky and other distillates also evaluated?

Our response: We thank the reviewer for this remark. Alcohol consumption was based on self-reported beer, wine and whisky consumption. Traditional alcoholic beverage was not evaluated in this study.

The classification of a current smoker as someone who stop smoking for less than 3 years is a very particular one and probably result in an over estimation of smokers.

Our response: We do agree that the wording is somehow inaccurate and misleading. Please read:

"*Participants who smoked at least one cigarette per day at the time of the study were classified as current smokers, and those who have smoked for at least 3 years in the past, but had stopped by the time of the study were classified as former smokers.*"

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any pre-specified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	8-9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	8-9

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2012-001217.R2
Article Type:	Research
Date Submitted by the Author:	20-Jul-2012
Complete List of Authors:	Dzudie, Anastase Kengne, Andre; South African Medical Research Council, National Collaborative Programme on Cardiovascular and metabolic Disease; The George Instute for Global Health, Muna, Walinjom Ba, Hamadou Menanga, Alain Kouam Kouam, Charles Abah, Joseph Monkam, Yves; General Hospital of Douala, Department of Internal Medicine Biholong, Christian; General Hospital of Douala, Department of Internal Medicine Mintom, Pierre Kamdem, Felicite; General Hospital of Douala, Department of Internal Medicine Djomou, Armel; General Hospital of Douala, Department of Internal Medicine Ndjebet, Jules; General Hospital of Douala, Department of Internal Medicine Ouambo, Cyrille Luma, Henry; General Hospital of Douala, Department of Internal Medicine Ngu, Kathleen Kingue, Samuel
Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Global health, Epidemiology
Keywords:	Hypertension < CARDIOLOGY, EPIDEMIOLOGY, PUBLIC HEALTH

Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Short title: Awareness, treatment and control of hypertension

Anastase Dzudie, MD, FESC(1); André Pascal Kengne, MD, PhD(2); Walinjom F.T. Muna, MD, PhD, FACC(3); Hamadou Ba, MD(1); Alain Menanga, MD (4); Charles Kouam Kouam, MD(5); Joseph Abah, MD(6); Yves Monkam, MD(1); Christian Biholong, MD(1); Pierre Mintom, MD(4); Félicité Kamdem, MD(1); Armel Djomou, MD(1); Jules Ndjebet, MD(1); Cyrille Ouambo, MD, PhD(1); Henri Luma, MD(1), Katleen Blackett Ngu, MD, FESC(6); Samuel Kingue, MD(6); On behalf of the CCS investigator group*.

(1) Department of Internal Medicine, Douala General Hospital and Buea Faculty of medicine, Cameroon

(2) NCRP or Cardiovascular and metabolic disease, South African Medical Research Council & University of Cape Town, Cape Town, South Africa

(3) Department of Internal Medicine, Faculty of Medicine and Biomedical Sciences, Yaounde, Cameroon

(4) Department of Internal Medicine, Yaounde General Hospital , Cameroon

(5) Department of Internal Medicine, Bafoussam Regional Hospital , Cameroon

(6) Department of Internal Medicine, Bamenda Military Hospital , North West Region, Cameroon

Correspondence to: Dr Anastase Dzudie, MD; FESC. Douala General Hospital; PO Box 4856, Douala General Hospital, Douala – Cameroon, Tel: +(237)79617981; Fax: +(237)33370146; email: aitdzudie@yahoo.com

Tables #4; Figures #1.

Word count: Abstract (265); Main text excluding reference, figure legend and references (3720)

* Members list in the appendix section

Abstract

Objectives. Hypertension has been established as a major public health problem in Africa, but its specific contributions to disease burden are still incompletely understood. We ~~quantified~~ report the ~~burden~~ prevalence and determinants of hypertension, detection, treatment and control rates among adults in major cities in Cameroon.

Design. Cross-sectional study

Settings. Community-based multicenter study in major cities in Cameroon

Participants. Participants were self-selected urban dwellers from the Center, Littoral, North-West and West Regions, who attended on May 17th 2011 a screening campaign advertised through mass media.

Primary and secondary outcomes measures. Hypertension defined as systolic (and/or diastolic) blood pressure ≥ 140 (90) mmHg, or ongoing blood pressure (BP) lowering medications.

Results. In all, 2120 participants (1003 women) were included. Among them, 1007 (prevalence rate 47.5%) had hypertension, including 319 (awareness rate 31.7%) who were aware of their status. The prevalence of hypertension increased with age overall and by sex and region. Among aware hypertensive participants, 191 (treatment rate 59.9%) were on regular BP lowering medication, and among those treated, 47 (controlled rate 24.6%) were at target BP levels (i.e. systolic (and diastolic) BP <140 (90) mmHg). In multivariable logistic regressions analysis, male gender, advanced age, parental history of hypertension, diabetes mellitus, elevated waist, and elevated body mass index (BMI) were the significant predictors of hypertension. Likewise, male gender, high BMI and physical inactivity were associated with poor control.

Conclusions. High prevalence of hypertension with low awareness, treatment and control were found in this urban population; these findings are significant and alarming with

consideration to the various improvements in the access to healthcare and the continuing efforts to educate communities over the past decades.

Word count - 265

Key Words: Hypertension, prevalence, awareness, treatment, control, Cameroon, Africa

Article summary

Article focus

- This article quantified the burden and determinants of hypertension, detection, treatment and control rates among self-selected adults in major cities in Cameroon, central Africa

Key messages

- The prevalence of hypertension was very high in this population, coupled with low detection, treatment and control rates.
- Age, gender and excess weight were the main drivers of the high prevalence, while the coincidence of classical cardiovascular risk factors was associated with poor control.

Strengths and limitations of this study

- Major strengths of this study include the large sample, the multicenter nature, the rigorous data collection on a range of determinants and provision of standardized prevalence figures.
- Limitations include the selection of participants, and hypertension diagnosis based on blood pressure measurement during a single encounter.

Introduction

Hypertension has been established as a major public health problem worldwide.[1] Several published studies suggest that hypertension is the commonest modifiable risk factor for stroke, congestive heart failure and kidney failure[2-5] in the sub-Saharan African (SSA) region. It is a major contributor to overall mortality risk in adults in the region.[6] Hypertension also seems to be more common in urban than rural population[7] of the SSA region.

Specific risks associated with various blood pressure (BP) readings have largely been established for populations in many parts of the developed world but this is not the case for countries of the developing world including the SSA region. There is considerable evidence that long-term BP lowering to what is considered either normal or optimal levels results in several significant and important health benefits.[8] When established norms for ideal or optimal BP are applied to SSA populations, it becomes very evident that the vast majority of eligible patients do not enjoy the benefits of BP lowering therapies, either because of under-diagnosis or the many other barriers to BP lowering medications prescription, access and compliance in this setting.[1 2] As a case in point, a survey in Cameroon about eight years ago found that only 23% of all individuals with hypertension at the community level were aware of their status.[9] Moreover, only 46% of those aware (11% of all those with hypertension) were on treatment, among whom only 19% (2% of all those with hypertension) achieved expected target BP levels.[9]

There is also evidence that SSA is undergoing very rapid transitions characterized by increasing urbanization, including the adoption of unhealthy lifestyles.[10 11] These transitions are paralleled by changes in the profile of chronic disease risk factors including

blood pressure.[7] Recently there has been increasing awareness of the threat that the looming chronic diseases pose to the health of the population in the Region at different levels.[12] This increasing awareness has catalyzed initiatives aimed at improving access to detection and care of chronic diseases including hypertension[13] in many countries of the region. The pace of the above mutations suggests that, data on the burden of hypertension, must be updated regularly, in order to provide the reliability needed in drawing-up health service and policy solutions.

The aim of this study was to assess the prevalence and determinants of hypertension, and including the detection, treatment and control rates, as well as the variability by region and gender in four major cities of Cameroon.

Material and methods

Study population and settings

This was a cross-sectional population-based study conducted in the regional capitals of the Centre (Yaounde), Littoral (Douala), North-West (Bamenda) and West (Bafoussam) administrative regions (out of a total of ten) of Cameroon. According to the Cameroon National Institute of Statistics,[14] the four participating regions had a total population of 9.98 million in 2010 (51% of the country's total population: 19.41 millions). In this same year, 57.5% of the national population was aged 15 years and above, and about 52% resided in what was defined as an urban area.[14] During three consecutive weeks leading to the specified day of the survey, daily announcements were made through radio and television, inviting all interested adults (or individuals aged 15 years and above) to report to any of the screening sites in participating cities. Such explanation included advice on the importance of measuring and knowing one's blood pressure under the slogan "I know my blood pressure. And you?". Announcements were also made in churches and market places. The study

protocol was approved by the Cameroon National Ethics Committee and signed informed consent obtained from each participant.

Data collection

The screening was conducted by trained medical personnel, simultaneously in the four cities on the specified date of May 17th 2011. All participants were subjected to a face-to-face interview during which data were collected (using a standardized questionnaire) on demographics, smoking habits and alcohol consumption, physical activity, parental history of hypertension, personal medical history (where the diagnosis was made by a physician) of hypertension including drug treatment, diabetes mellitus, gout and dyslipidemia. The physical examination included blood pressure (BP) and anthropometric measurements. BP (systolic and diastolic) was measured using a standardized protocol with the participant in a seated position, and after at least 10 minutes rest. Participants with evidence of recent (less than 30 minutes) alcohol intake or smoking were invited to a 30 minutes rest before BP measurement. BP measurements were performed on the right arm using automated sphygmomanometers (OMRON M3 HEM-7200-E Omron Matsusaka Co Ltd, Japan). Special attention was given to the use of appropriate cuff sizes (13×23 cm or 16×30 cm). Weight (to the nearest 0.5 kg) was measured with the use of an automated scale. Participants were permitted to keep on light clothing. Height (in meters to the nearest 0.5cm) was measured using a wooden platform and a height rule. Body mass index (BMI in kg/m^2) was calculated as weight (kg)/[height (m) X height (m)]. Waist circumference was measured midway between the iliac crest and the lower rib margin and the hip circumference was measured at the intertrochanteric level. Waist-to-hip ratio (WHR) was calculated as waist (cm)/Hip (cm) circumferences.

Definitions

Respondents were classified as hypertensive if they had a systolic (and/or diastolic) BP of 140 (90) mmHg or higher, or if they were on blood pressure lowering medications over the last 15 consecutive days. Participants with hypertension were considered to be aware of their status if they answered 'yes' to the question 'have you ever been told by a doctor or health professional that you had hypertension?'. Treatment of high BP was defined by the use of BP lowering medications. Hypertension was considered to be controlled among treated individuals when systolic (and diastolic) SBP was < 140 (90) mmHg or <130 (80) mmHg in individuals with diabetes. Waist circumference >94 cm in men or 80 cm in women was considered to be high. Excessive alcohol consumption was based on intake of either more than three (two for women) standard glasses of wine per day or more than ten (five for women) local beers (1 local beer contains 28 g of alcohol) per week. Traditional alcohol beverages were not assessed. Participants who smoked at least one cigarette per day at the time of the study were classified as current smokers, and those who have smoked for at least 3 years in the past, but had stopped by the time of the study were classified as former smokers. Regular non-work related physical activity was considered in participants reporting at least 30 min of intense physical activity, once a week or more.

Handling of participants with high blood pressure

Participants with hypertension (known or screened-detected) received on-site medical counseling and were referred back to their attending physician (known cases), or to specialists within the vicinity of the participant's residential area for workup and long-term management. Few participants with excessively high BP with or without suspected acute target organ damage were immediately referred to emergency departments for appropriate care.

Statistical analysis

Data analysis used the Statistical Package for Social Sciences (SSPS Inc, Chicago, IL) version 17.0 software. Results are summarized as count and percentages for qualitative variables and

mean and standard deviation (SD) for quantitative variables. Age-adjusted prevalence was calculated using the Cameroon National population's age structure in 2010 as standard population.[15] Direct standardization methods was applied.[16] Group comparisons used chi square tests and equivalents for qualitative variables and Student t-test, analysis of the variance (ANOVA) for quantitative variables. Logistic regressions analyses were used to investigate potential determinants of prevalent hypertension and control. A p-value<0.05 was used to characterize statistically significant results.

Sensitivity analysis

The main analyses were based on a single blood pressure measurement. To assess the potential effects of 'regression to the mean' phenomenon on the prevalence of hypertension, a sensitivity analysis was conducted among participants with a raised initial blood pressure (SBP/DBP>=140/80 mmHg) and who had their blood pressure taken a second time on the same day. This analysis was based on the average of the first and second measurements.

Results

The study population

Two thousand one hundred and twenty eligible participants reported for screening in the four regions including 649 (30.6%) in the Centre, 1167 (54.1%) in the Littoral and 304 (14.3%) in the West and North West regions. Their overall profile including gender and region is summarized in Table 1. Participants included 1003 women (47.3%). Compared with men, women had similar age (43 vs. 44 years, p=0.19), similar waist circumference (93 vs. 93 cm, p=0.80), and similar history of diabetes mellitus, dyslipidemia and gout (all p≥0.07, Table 1). They were likely to have higher body mass index, higher prevalence of parental history of hypertension, lower systolic and diastolic blood pressure, and were less likely to be either a smoker or alcohol drinker and physically active (all p≤0.001. Table 1). With a few

exceptions, the above pattern was consistent within participating regions. However, the small numbers of recruits in some subgroups translated into non-significant men/women differences (Table 1). With the exception of smoking (p=0.07), differences were also apparent in the baseline profile across Regions (all p≤0.01 for differences across regions).

Blood pressure profile

Mean systolic and diastolic BP (SD) at the total population level (men vs. women) was 139 (25) vs. 134 (28) mmHg (p<0.001), and 83 (17) vs. 80 (17) mmHg (p=0.001). Mean systolic BP steadily increased with increasing age in men and women and across participating regions. Diastolic BP also increased with increasing age, but only up to the fourth and fifth decade of age, after which the pressure stabilized. This was observed in men and women and across regions (Figure 1).

The distribution of participants by BP categories according to the 2003 ESH/ESC classification [17] was examined by sex and regions, overall and by age groups. An optimal BP (systolic BP<120 and diastolic BP<80 mmHg) was observed in 21.6% of men and 29.6% of women. The prevalence of optimal or normal BP decreased with increasing age in men and women (all p≤0.001 for linear trend). Conversely, with the exception of grade 1 hypertension (both p≥0.09 for linearity) and high normal BP in women only (p=0.13), the prevalence of all other BP categories linearly increased with increasing age (all p<0.001 for linear trend). Similar trends were also observed across participating regions. However, the distribution of participants across BP categories varied significantly by region (p<0.0001)

Prevalence of hypertension, and awareness and control rates

The prevalence of hypertension was 47.5% overall, and 50.1% and 44.6% in men and women respectively (p<0.001), Table 3. As expected, prevalence rate sharply increased with age down from 31.7% (men) and 20.2% (women) in the age group <35 years, up to 77.6% (men) and 75.2% (women) in the age group 55 years and above (Table 3). Awareness rate increased

with increasing age in men and women (both p<0.001 for linear trend). Among participants with hypertension, 24.6% in men and 40.5% in women were aware of their condition, and those remaining were newly diagnosed. Of those aware of their hypertensive status, 57.9% in men and 61.3% in women were on BP lowering medications, similarly across age groups in men (p=0.53 for linear trend), and with a modest linearly increasing trend with age in women (p=0.03, Table 3). Among treated patients, 27.5% in men and 38.7% in women were at target BP levels [i.e. systolic (and diastolic) BP <140 (90) mmHg), and similarly across age strata (both p≥0.06 for linear trend). Control rate was about 10% lower when the target BP level of <130 (80) was applied to participants with diabetes (Table 3).

Crude prevalence of hypertension, awareness and treatment varied significantly across participating regions (all p<0.001). The highest crude prevalence (53.6%) was observed in the Littoral region, while the highest crude awareness (60.9%) and treatment rates (49.0%) were observed in provinces other than Centre ad Littoral (Table 3). Control rate was also higher in those two region when the threshold level of 140/90 mmHg was applied to all treatments participants (p<0.001). This difference however was non-significant when the threshold of 130/80 mmHg was applied to participants with diabetes. The age trends in prevalence, awareness, treatment and control across regions were largely similar to those observed in men and women (Table 3).

Predictors of hypertension and control among urban dwellers

Unadjusted and adjusted odd ratios and 95% confidence intervals for ~~Determinants~~ the association of prevalent hypertension with potential predictors are shown in Table 3. In multivariable logistic regression models adjusted for age, sex, parental history of hypertension, body mass index and region, the significant predictors of prevalent hypertension were ~~In unadjusted logistic regressions analysis,~~ male ~~gender~~sex, increasing age, Region, parental history of hypertension, personal history of diabetes, ~~gout, excessive alcohol~~

consumption, high BMI and high waist circumference were associated with prevalent hypertension (Table 3). In multivariable adjusted models, history of gout and excessive alcohol consumption were no longer associated with prevalent hypertension. Table 4 shows the crude and adjusted odds ratios (ORs) of hypertension control among treated patients. In multivariable models with similar level of adjustment (Table 4), Male male sex, high BMI and physical inactivity were associated with poor control of hypertension, while being from Regions other than Centre or Littoral was associated with good control among treated patients (Table 54).

Sensitivity analysis

Among participants with newly diagnosed hypertension based on the first blood pressure measurement (688 participants), 537 (78.0%) had a valid second measurement. Their mean blood pressure (SD) was 159.4 (19.0) for systolic and 94.4 (14.2) mmHg for diastolic based on the first measurement. Equivalents were 154.5 (19.0) and 93.0 (13.1) mmHg based on the average of the two measurements. Of the 537 participants 461 (85.8%) had hypertension (systolic/diastolic blood pressure>=140/90 mmHg) using the average of the two blood pressure measurements.

Discussion

In this self-selected urban adult population study from Cameroon, we found a high prevalence of hypertension, coupled with low detection, treatment and control rates. The high prevalence was largely driven by age, as well as by gender and excess weight. However, among those diagnosed and on treatment, control rate was similar across age groups, although there were suggestions of regional differences, possibly reflecting underling differences in the access to healthcare and health resources utilization. Our study provides comparative data

across major cities in Cameroon and suggests findings compatible with previously reported high prevalence rates of hypertension in the country.

Prevalence of hypertension

During the last ten years, at least two prevalence studies on hypertension have been reported in urban Cameroon, applying similar definitions for hypertension, but different sampling strategies.[7 9 18] The age-adjusted prevalence of hypertension in the current study is higher than that reported by Kamadjeu[9] in 2003, but similar to the findings of Fezeu[7] around that same time. This balance of findings would tend to suggest that the prevalence of hypertension in this setting is either stabilizing or growing at a much slower pace than previously reported.[7]

Elsewhere, available data on hypertension in Africa are from very heterogeneous studies, and therefore offer less opportunities for reliable comparison.[3] Such heterogeneities include differences in sampling methods and study settings (predominance of hospital based study), the type of participants enrolled, the measurements of blood pressure and definition of hypertension, and the time period when the study was conducted.[19] Reliable, large-scale, population-based data on high blood pressure in sub-Saharan Africa are very limited; however available recent studies provide findings that demonstrate similarly high prevalence of hypertension in urban settings.[20-22] Moreover, those findings already tend to be similar to those reported in the developed world,[23 24] therefore, raising serious concerns given the young age of clinical onset of hypertension in Africa.

Awareness, treatment and control of hypertension

In Cameroon, over the last ten years, there have been a number of initiatives aimed at scaling up the fight against chronic diseases in general, and hypertension and diabetes mellitus in particular,[25] including: 1) the adoption of a National Strategy for hypertension and diabetes;[25] and 2) the development of training and task-shifting programmes to improve

detection and management at primary care level.[13 26] Findings from our study would tend to suggest that the good will contained in the National Strategy has perhaps not yet been fully translated into actions with sizable positive effects on the health of the population. For instance, the Strategy aimed to improve level of risk factors by 25% and achieve optimal control among those diagnosed with the condition.[25] However, we found awareness, treatment and control rates which were within the range of those previous reported in Cameroon prior to the adoption of the Strategy[7 9] and recently in other settings in Africa.[20 22 25] The low awareness rate if confirmed, could be blamed on low detection activity and accordingly non-optimal performance of the National strategy. It is also possible that many participants already diagnosed with hypertension, and perhaps on treatment and controlled on such treatment, did not feel the need to attend the screening campaign again. This would have the undesirable effect of biasing our estimates by providing much lower than the true figures. It is also possible that those with known and treated condition instead turned out in higher number to use the campaign as an opportunity for their health checkup free of charge. Our stratified analyses suggest that this mix could vary substantially by participating centers. In general however, low awareness of hypertension has been reported as a global phenomenon,[27] although the magnitude may be less important in the developed world[23 28]. In the USA for instance, awareness of hypertension is as higher as 76%,[28] reflecting the success achieved by a coordinated policy to detect individuals with higher-than-optimal blood pressure levels.

The low treatment and control rates in our study reflect the interplay between many factors which were not directly captured by the current study. These include both patient-level, healthcare provider level and health system level factors. Indeed, patients are expected to be treated and controlled only if they can access appropriate health services, receive adequate advice and prescriptions, and subsequently afford and adhere to those prescriptions.

Accessibility to health care facility has likely improved in urban settings in Cameroon in recent years. However the physician-to-population ratio, just like in many other countries in the region, is still very low[29] and may explain the low awareness and treatment gaps. Affordability of the cost of care also remains a major barrier in the study setting where out-of-pocket spending is the main source of funding for healthcare costs. Adherence to prescribed medications is another patient-level determinant of risk factor control not investigated in the present study. Studies in Africa have shown that non-adherence to treatment and follow-up for hypertension was very common.[30-32] In one intervention study in Cameroon for instance, just about half of participants were still in the programme at 1-year of follow-up.[31]

Potential limitations and strengths of our study

The present study has some limitations. Participants were self-selected and may therefore not necessarily be representative of the general population in participating cities. Access to mass media (radio and television) is almost universal in major cities in the countries, and there is therefore no suggestion that advertisement of the campaign would have selectively reached certain portions of the population. It remains however; that participants in the study could still differ from the general population by being more or less health conscious, and having less severe disease for example, which could affect some parameters in the study. The study used a cross-sectional design, which precludes any causality inference. Diagnosis of hypertension was based on blood pressure measurements during a single encounter, which is at variant with guidelines recommendations for hypertension diagnosis using two measurements recorded on three separate occasions.[17] This may have overestimated the prevalence of hypertension and underestimated the level of blood pressure control. This however, would not affect comparisons with previous epidemiological studies that have used similar measurement methodology. Diagnosis of hypertension among those with no history of hypertension in our study was based on a single blood pressure measurement. Our sensitivity analysis suggests

that this approach could inflated the crude prevalence by about 5.4% and 4.6% among those not known to have hypertension prior to the survey and at the total population level respectively. Nevertheless, even after accounting for this possible effect, our estimates would still be within sampling variation of the figures previously reported in this setting. It is also of note that no participant received a definitive diagnosis of hypertension as the result of taking part in this study. Those with elevated blood pressure levels were instead referred to health care facilities for further evaluation. The strengths of this study include the large sample of the general population and, the rigorous collection of various lifestyle factors, medical data and blood pressure measurements by trained staff according to standardized protocols, the adequate standardization of prevalence and allowing comparisons with other African countries. In addition, our sampling approach provides evidence that simple announcements through mass media can attract from the community a large number of individual at risk of undiagnosed hypertension.

Conclusions

In conclusion, our study has ~~provides~~ provided findings ~~suggesting~~ that are in line with the high prevalence of hypertension previously reported in urban settings in Africa. The study further suggests that ~~Detection~~ efforts to detect~~,~~ and treat~~ment and control efforts~~to the targets those with the disease are ~~likely~~ still ~~well~~ below optimal. This raises serious concerns about the prospects of having to care very soon for both patients with higher-than-optimal blood pressure and many more with target organ lesions subsequent to longstanding hypertension. There are already some indications that the burden of stroke, end-stage renal disease and heart failure related to hypertension is growing in the country and the region.[2 6 33]

Perspectives

The low awareness, treatment and control rates of hypertension in this potentially health conscious urban sub-Saharan population invite innovative approaches to improve prevention,

detection, treatment of hypertension beyond the traditional healthcare facilities based approaches which are currently in force in many countries in the region.

Declaration of competing interest. None for all authors.

Author contribution. Dzudie and Kengne had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Dzudie, Kengne, Muna, Ngu, Kingue.

Acquisition of data: Ba, Menanga, Kouam Kouam, Abah, Monkam, Biholong, Mintom, Kamdem, Djomou, Njebet, Ouambo, Luma,

Analysis and interpretation: Dzudie, Kengne, Muna

Drafting of the manuscript: Dzudie, Kengne, Muna

Critical revision of the manuscript for important intellectual content: all co-authors

Acknowledgements

The authors would like to express their gratitude to the following bodies and individuals for their contribution to the success of this study: 1) The Cameroon Ministry of public health for providing the blood pressure devices and health staff; 2) The executive committee and members of the Cameroon Cardiac Society for their support for data collection; 3) Servier Pharma Cameroon for a financial contribution to support data processing and drafting of the manuscript; 4) All specialist physicians, enthusiastic general practitioners, medical students and nurses involved in data collection; and 5) All those who helped at the different stages of

the project and the fellow Cameroonians who volunteered across the four participating cities to take part in the study.

Data sharing statement: No additional data available

Appendix 1

Cameroon Cardiac Society (CCS) investigators group:

(1) Douala: Anastase Dzudie, Hamadou Ba, Henri Roger Ngote, Christian Biholong, Félicité Kamdem, Armel Djomou, Jules Njebet, Cyrille Ouambo, Roger Mboulley Kotto, Barbara Bouellet Abeng, Marielle Epacka Ewane Lobe and Yves Monkam.

(2) Yaounde : Alain Menanga, Pierre Mintom, Euloge Yiagnigni, Mérimée Ouankou, Christophe Nouedoui, Pierre Ndobo, Marie Ntep, Monique Kenfack, Sylvie Ndongo, Martine Tchuem, Edvine Wawo, Walinjom F.T. Muna, Katleen Ngu Blackett and Samuel Kingue.

(3) Bafoussam: Charles Kouam Kouam

(4) Bamenda: Joseph Abah.

References

1. Kearney PM, Whelton M, Reynolds K, et al. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005;365:217-23.

2. Kengne AP, Anderson CS. The neglected burden of stroke in Sub-Saharan Africa. *Int J Stroke* 2006;1:180-90.

3. Addo J, Smeeth L, Leon DA. Hypertension in sub-saharan Africa: a systematic review. *Hypertension* 2007;50:1012-8.

4. Kengne AP, Amoah AG, Mbanya JC. Cardiovascular complications of diabetes mellitus in sub-Saharan Africa. *Circulation* 2005;112:3592-601.

5. Damasceno A, Cotter G, Dzudie A, et al. Heart failure in sub-saharan Africa: time for action. *J Am Coll Cardiol* 2007;50:1688-93.

6. Kengne AP, Awah PK. Classical cardiovascular risk factors and all-cause mortality in rural Cameroon. *Qjm* 2009:doi:10.1093/qjmed/hcn175.

7. Fezeu L, Kengne AP, Balkau B, et al. Ten-year change in blood pressure levels and prevalence of hypertension in urban and rural Cameroon. *J Epidemiol Community Health* 2010;64:360-5.

8. Turnbull F. Effects of different blood-pressure-lowering regimens on major cardiovascular events: results of prospectively-designed overviews of randomised trials. *Lancet* 2003;362:1527-35.

9. Kamadjeu RM, Edwards R, Atanga JS, et al. Prevalence, awareness and management of hypertension in Cameroon: findings of the 2003 Cameroon Burden of Diabetes Baseline Survey. *J Hum Hypertens* 2006;20:91-2.

10. Leon DA. Cities, urbanization and health. *Int J Epidemiol* 2008;37:4-8.

11. Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr* 2006;84:289-98.

12. de-Graft Aikins A, Unwin N, Agyemang C, et al. Tackling Africa's chronic disease burden: from the local to the global. *Globalization and health* 2010;6:5.

13. Lekoubou A, Awah P, Fezeu L, et al. Hypertension, diabetes mellitus and task shifting in their management in sub-Saharan Africa. *Int J Environ Res Public Health* 2010;7:353-63.

14. Cameroon's National Institute of Statistics. Statistical Yearbook 2010, 2011:39-52.

15. Cameroon's National Institute of Statistics. Population du Cameroun en 2010, 2011.

16. Woodward M, editor. *Epidemiology: study design and data analysis*. Second ed. New York: Chapman & Hall/CRC, 2005.

17. Mancia G, De Backer G, Dominiczak A, et al. 2007 Guidelines for the Management of Arterial Hypertension: The Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *J Hypertens* 2007;25:1105-87.

18. Kengne AP, Awah KP, Fezeu L, et al. The burden of high blood pressure and related risk factors in urban sub-Saharan Africa: Evidences from Douala in Cameroon. *African Health Sciences* 2007;7:38-44.

19. Danaei G, Finucane MM, Lin JK, et al. National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5.4 million participants. *Lancet* 2011;377:568-77.

20. Jenson A, Omar AL, Omar MA, et al. Assessment of hypertension control in a district of Mombasa, Kenya. *Glob Public Health* 2011;6:293-306.

21. Ulasi, II, Ijoma CK, Onodugo OD. A community-based study of hypertension and cardio-metabolic syndrome in semi-urban and rural communities in Nigeria. *BMC Health Serv Res* 2010;10:71.

22. Damasceno A, Azevedo A, Silva-Matos C, et al. Hypertension prevalence, awareness, treatment, and control in mozambique: urban/rural gap during epidemiological transition. *Hypertension* 2009;54:77-83.

23. Wagner A, Sadoun A, Dallongeville J, et al. High blood pressure prevalence and control in a middle-aged French population and their associated factors: the MONA LISA study. *J Hypertens* 2011;29:43-50.

24. Wolf-Maier K, Cooper RS, Banegas JR, et al. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. *Jama* 2003;289:2363-9.

25. Njamnshi AK, Bella Hiag A, Mbanya JC. From research to policy: the development of a national diabetes programme in Cameroon. *Diabetes Voice* 2006;55:18-21.

26. Kengne AP, Sobngwi E, Fezeu L, et al. Setting-up nurse-led pilot clinics for the management of non-communicable diseases at primary health care level in resource-limited settings of Africa *PAMJ* 2009;3:10.

27. Marques-Vidal P, Tuomilehto J. Hypertension awareness, treatment and control in the community: is the 'rule of halves' still valid? *J Hum Hypertens* 1997;11:213-20.

28. Cheung BM, Ong KL, Man YB, et al. Prevalence, awareness, treatment, and control of hypertension: United States National Health and Nutrition Examination Survey 2001-2002. *J Clin Hypertens (Greenwich)* 2006;8:93-8.

29. World Health Organisation. Task shifting to tackle health worker shortage. Geneva, 2007.

30. Kengne AP, Awah PK, Fezeu LL, et al. Primary health care for hypertension by nurses in rural and urban sub-Saharan Africa. *J Clin Hypertens (Greenwich)* 2009;11:564-72.

31. Labhardt ND, Balo JR, Ndam M, et al. Improved retention rates with low-cost interventions in hypertension and diabetes management in a rural African environment of nurse-led care: a cluster-randomised trial. *Trop Med Int Health* 2011.

32. Dennison CR, Peer N, Steyn K, et al. Determinants of hypertension care and control among peri-urban Black South Africans: the HiHi study. *Ethn Dis* 2007;17:484-91.

33. Halle MP, Kengne AP, Ashuntantang G. Referral of patients with kidney impairment for specialist care in a developing country of sub-Saharan Africa. *Ren Fail* 2009;31:341-8.

Legend for figures and tables

Figure 1: Mean systolic and diastolic blood pressure by age groups for men (left panel) and women (right panel).

Figure 2 – Blood pressure control among participants with hypertension according to the number of cardiovascular risk factors.

Risk factors considered were: overweight or obesity, high waist, current or past smoking, physical inactivity, diagnosed diabetes, dyslipidemia. None of the 116 participants with none of the risk factor had hypertension.

Table 1 - General characteristics of the study population overall and by Region

Characteristic	Regions												
	Centre			Littoral			North-West and West			p region	Overall		
	Men	Women	P	Men	Women	P	Men	Women	p		Men	Women	p
N	376	273		609	558		132	172		<0.001	1117	1003	
Mean age, yrs. (SD)	41 (12)	42 (14)	0.43	45 (13)	43 (14)	0.33	48 (14)	45 (14)	0.08	<0.001	44 (13)	43 (14)	0.19
Age groups, n			0.26			0.006			0.22	<0.001			0.01
<35 years	134	97		145	180		23	44			302	321	
35-44 years	99	57		154	108		32	40			285	205	
45-54 years	86	65		163	139		34	47			284	251	
≥55 years	57	54		146	131		43	41			246	226	
Mean BMI, kg/m^2 (SD)	26.2 (4.0)	27.2 (4.5)	0.002	26.9 (4.8)	29.0 (6.3)	<0.001	27.6 (5.0)	29.3 (5.4)	0.006	<0.001	26.7 (4.6)	28.6 (5.8)	<0.001
Waist girth, cm (SD)	96 (13)	94 (12)	0.04	91 (13)	91 (15)	0.31	95 (12)	97 (12)	0.15	<0.001	93 (13)	93 (14)	0.80
Mean SBP, mmHg (SD)	133 (22)	129 (24)	0.06	142 (26)	139 (30)	0.05	136 (25)	125 (25)	<0.001	<0.001	139 (25)	134 (28)	<0.001
Mean DBP, mmHg (SD)	77 (17)	77 (16)	0.98	85 (17)	82 (18)	0.001	85 (15)	79 (15)	0.001	<0.001	83 (17)	80 (17)	0.001
Parental hypertension, n	77	77	0.02	158	191	0.002	38	55	0.62	0.01	273	323	<0.001
History of diabetes, n	27	27	0.22	27	31	0.42	21	31	0.65	<0.001	75	89	0.07
History of dyslipidemia, n	1	0	>0.99	4	9	0.16	0	0	N/A	0.005	5	9	0.28
History of gout, n	0	1	0.42	13	9	0.53	1	0	0.43	<0.001	14	10	0.68
Physical activity, n	160	86	0.004	334	180	<0.001	82	104	0.77	<0.001	576	370	<0.001
Smoking, n			<0.001			<0.001			<0.001	0.07			<0.001
Never	320	267		500	540		113	170			933	977	
Former	21	26		43	7		4	0			68	12	
Current	35	36		66	11		15	2			116	14	
Excessive alcohol, n	85	17	<0.001	147	51	<0.001	51	32	<0.001	<0.001	283	100	<0.001

BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; SD, standard deviation

Table 2 - Hypertension prevalence, awareness and control among self-selected urban dwellers in Cameroon

Gender Region	Variable	Overall	Overall*	Age groups (years)				P-trend
				<35	35-44	45-54	≥55	
Centre	Prevalence (%)	35.4	27.3 (23.3-31.3)	15.1	28.2	48.3	70.3	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	230	230	35	44	73	78	
	Awareness (%)	30.4	12.5 (9.3-15.7)	0	22.7	31.5	47.4	<0.001
	Among hypertensives (n)	70	70	0	10	23	37	
	Treatment (%)	61.4	21.9 (13.6-30.2)	NA	50.0	52.2	70.3	0.13
	Among aware hypertensives (n)	43	43	NA	5	12	26	
	Control A (%)	25.6	6.7 (2.5-10.9)	NA	0	33.3	26.9	0.41
	Among treated hypertensive (n)	11	11	NA	0	4	7	
	Control B (%)	25.6	6.7 (2.5-10.9)	NA	0	33.3	26.9	0.41
	Among treated hypertensive (n)	11	11	NA	0	4	7	
Littoral	Prevalence (%)	53.6	43.6 (39.2-48.0)	33.8	45.0	61.7	76.2	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	626	626	110	118	187	211	
	Awareness (%)	25.1	15.1 (11.3-18.9)	9.1	11.9	25.1	40.8	<0.001
	Among hypertensives (n)	157	157	10	14	47	86	
	Treatment (%)	49.0	38.7 (16.7-60.7)	30.0	57.1	46.8	51.2	0.42
	Among aware hypertensives (n)	77	77	3	8	22	44	
	Control A (%)	18.2	26.8 (-13.7 to 67.3)	33.3	12.5	22.7	15.9	0.60
	Among treated hypertensive (n)	14	14	1	1	5	7	
	Control B (%)	18.2	26.8 (-13.7 to 67.3)	33.3	12.5	22.7	15.9	0.60
	Among treated hypertensive (n)	14	14	1	1	5	7	
Others	Prevalence (%)	49.7	34.4 (26.6-42.2)	22.4	30.6	51.8	85.7	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	151	151	15	22	42	72	
	Awareness (%)	60.9	30.3 (17.7-42.9)	13.3	40.9	53.5	77.8	<0.001
	Among hypertensives (n)	92	92	2	9	25	56	
	Treatment (%)	77.7	91.6 (5.6-178)	100	77.8	84.0	73.2	0.30
	Among aware hypertensives	71	71	2	7	21	41	
	Control A (%)	31.0	12.9 (4.7-21.1)	0	42.9	14.3	39.0	0.22
	Among treated hypertensive (n)	22	22	0	3	3	16	
	Control B (%)	56.3	51.5 (-9.7 to 113)	50.0	57.1	33.3	68.3	0.12
	Among treated hypertensive (n)	40	40	1	4	7	28	
Men	Prevalence (%)	50.1	41.3 (36.9-45.7)	31.7	38.9	57.2	77.6	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	560	560	96	111	162	191	
	Awareness (%)	24.6	13.5 (10.0-17.0)	6.3	12.6	21.6	43.5	<0.001
	Among hypertensives (n)	138	138	6	14	35	83	
	Treatment (%)	57.9	54.6 (19.3-89.9)	50	64.2	65.7	54.2	0.53
	Among aware hypertensives	80	80	3	9	23	45	
	Control A (%)	18.8	28.2 (-12.0 to 68.6)	33.3	22.2	21.7	15.5	0.36
	Among treated hypertensive (n)	15	15	1	2	5	7	
	Control B (%)	27.5	50.3 (-6.3 to 107)	66.6	22.2	26.1	26.7	0.49
	Among treated hypertensive (n)	22	22	2	2	6	12	
Women	Prevalence (%)	44.6	32.5 (28.8-36.2)	20.2	35.6	55.8	75.2	<0.001
	SBP/DBP≥140/90 mmHg or treatment (n)	447	447	64	73	140	170	
	Awareness (%)	40.5	20.9 (15.6-26.2)	9.3	26.0	42.8	54.5	<0.001
	Among hypertensives (n)	181	181	6	19	60	96	
	Treatment (%)	61.3	43.3 (13.9-72.7)	33.3	57.9	53.3	68.9	0.03
	Among aware hypertensives	111	111	2	11	32	66	
	Control A (%)	28.8	8.0 (4.6-13.8)	0	18.1	21.8	34.8	0.08
	Among treated hypertensive (n)	32	32	0	2	7	23	
	Control B (%)	38.7	12.8 (7.2-18.4)	0	2.7	31.3	45.5	0.06
	Among treated hypertensive (n)	43	43	0	3	10	30	

Data are percentages with numerators below. Control A, blood pressure below 140/90 mmHg or 130/80 mmHg among diabetic patients; Control B, blood pressure below 140/90 mmHg among all participants. DBP, diastolic blood pressure; NA, not applicable SBP, systolic blood pressure.

* Age standardized according to the 2010 Cameroon national population distribution.

Table 3 - Crude and adjusted odds ratios for predictors of hypertension among self-selected urban dwellers in Cameroon.

Variable	Category	Unadjusted odd ratios (95% CI)	p	Adjusted odd ratios (95% CI)*	p
Sex	Men	1.25 (1.05-1.48)	0.01	1.63 (1.34-2.00)	<0.001
Age	<35 years	1 (reference)	<0.001	1 (Reference)	<0.001
	35-44 yrs	1.74 (1.35-2.25)		1.32 (1.01-1.73)	
	45-54 yrs	3.75 (2.93-4.81)		2.81 (2.16-3.64)	
	≥55 yrs	9.41 (7.12-12.43)		8.27 (6.19-11.04)	
Region	Centre	1 (Reference)	<0.001	1 (Reference)	<0.001
	Littoral	2.11 (1.73-2.57)		1.89 (1.52-2.36)	
	Others	1.80 (1.36-2.37)		1.38 (1.01-1.89)	
Parental hypertension	Yes	1.47 (1.21-1.77)	<0.001	1.55(1.25-1.92)	<0.001
Diabetes mellitus	Yes	3.77 (2.61-5.44)	<0.001	2.63 (1.75-3.94)	<0.001
Dyslipidemia	Yes	2.00 (0.67-5.98)	0.22	1.55 (0.47-5.11)	0.47
Gout	Yes	3.36 (1.33-8.49)	0.01	1.70 (0.62-4.67)	0.30
Smoking	Never	1 (Reference)	0.11	1 (Reference)	0.62
	Former	1.59 (1.01-2.51)		0.96 (0.59-1.65)	
	Current	0.90 (0.63-1.29)		0.82 (0.54-1.22)	
Physical activity	No	0.90 (0.76-1.07)	0.23	1.13 (0.93-1.38)	0.21
Excessive alcohol	Yes	1.33 (1.06-1.66)	0.01	1.05 (0.81-1.36)	0.70
Body mass index	Normal	1 (Reference)	<0.001	1 (Reference)	<0.001
	Overweight	2.03 (1.65-2.50)		1.94 (1.54-2.45)	
	Obese	3.54 (2.83-4.43)		3.32 (2.57-4.29)	
High waist girth		2.12 (1.78-2.52)	<0.001	1.94 (1.51-2.48)	<0.001

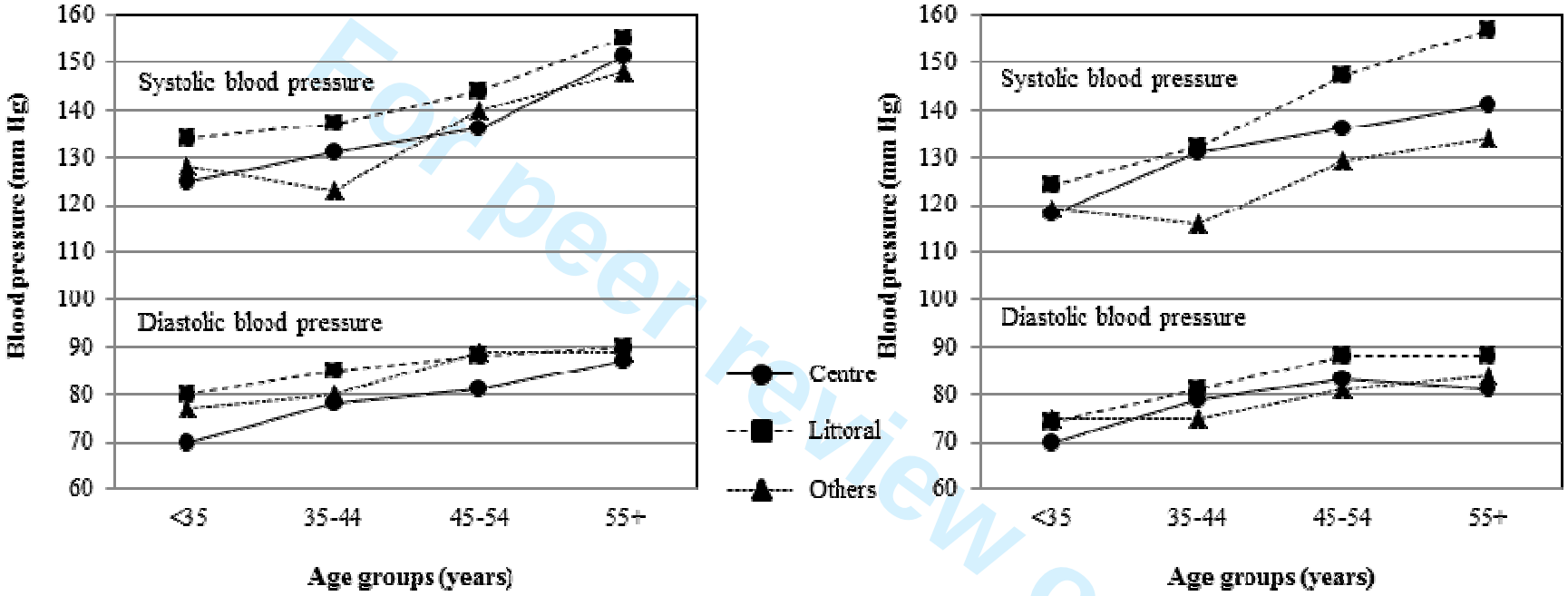
* age, sex, parental history of hypertension, body mass index and region adjusted; CI, confidence interval

Table 4 - Crude and adjusted odds ratios for predictors of hypertension control among self-selected and treated hypertensives in four main cities of Cameroon.

Variable	Category (%)	Unadjusted odd ratios (95% CI)	P	Adjusted odd ratios (95% CI)*	p
Sex	Men	059 (0.35-1.00)	0.05	0.47 (0.26-0.86)	0.01
Age	<35 years	1.00 (Reference)	0.87	1.00 (Reference)	0.63
	35-44 yrs	0.54 (0.12-2.32)		0.38 (0.07-1.99)	
	45-54 yrs	0.68 (0.19-2.45)		0.57 (0.13-2.41)	
	≥55 yrs	0.67 (0.19-2.34)		0.46 (0.11-1.88)	
Region	Centre	1.00 (Reference)	<0.001	1.00 (Reference)	<0.001
	Littoral	0.72 (0.35-1.50)		0.70 (0.33-1.52)	
	Others	3.36 (1.64-6.87)		3.50 (1.65-7.42)	
Parental hypertension	Yes	1.44 (0.87-2.40)	0.16	1.56 (0.89-2.75)	
Diabetes mellitus	Yes	2.73 (1.60-4.67)	<0.001	1.83 (0.98-3.39)	0.06
Dyslipidemia	Yes	0.74 (0.08-6.75)	0.79	1.30 (0.13-13.26)	0.83
Gout	Yes	NA (None)			
Smoking	Never	1.00 (Reference)	0.53	1.00 (Reference)	0.72
	Former	0.79 (0.21-2.89)		1.26 (0.30-5.34)	
	Current	0.32 (0.04-2.57)		0.44 (0.05-3.97)	
Physical activity	No	0.30 (0.17-0.56)	<0.001	0.36 (0.20-0.66)	0.001
Excessive alcohol	Yes	0.59 (0.26-1.32)	0.20	0.64 (0.26-1.60)	0.34
Body mass index	Normal	1.00 (Reference)	0.002	1.00 (Reference)	0.003
	Overweight	0.41 (0.22-0.77)		0.44 (0.22-90)	
	Obese	0.34 (0.18-0.66)		0.28 (0.14-0.59)	
High waist girth		0.86 (0.51-1.44)	0.56	0.77 (0.33-1.77)	0.54

* age, sex, parental history of hypertension, body mass index and region adjusted; CI, confidence interval.

Figure 1:



Manuscript ID bmjopen-2012-001217.R1 entitled "Prevalence, awareness, treatment and control of hypertension in a self-selected sub-Saharan African urban population: A cross-sectional study

Dear Editor,

We are grateful to the reviewers for their time and additional constructive comments on our manuscript.

Their new suggestions have been accounted for as shown in red colour (or with the track changes function) in the manuscript and further explained in the point-by-point response below. Each time our response includes material from the manuscript, it is indicated in *italic* and **in black** colour if such a material was already present in the original version of the manuscript or in **red colour** for new material.

We look forward to the outcome of your assessment.

Yours sincerely,
Andre Pascal Kengne
On behalf of the co-authors

Reviewer(s)' Comments to Author:

Reviewer: Dr Juliet Addo
King College London

There is no competing interests.
The authors have addressed the concerns raised in the previous review to a large extent. The points which cannot be addressed have been acknowledged. I am making a few points for modification below but do not need to see this again.

Our response: We thank you for the appreciation

The previous review have been addressed considerably. There are a few points that need attention.
Firstly, the aims in the abstract have not been rephrased as done in the main text. They do mention that they will quantify the burden of hypertension.

Our response: We have changed the wording. The sentence now reads:

"*We report the prevalence and determinants of hypertension, detection, treatment and control rates among adults in major cities in Cameroon.*"

In the results section on page 10, there is the mention of optimal BP. This needs to be defined.

Our response: This is based on the ESC 2007 guideline definition. We have now provided the definition. The relevant sentence reads:

"*An optimal BP (systolic BP<120 and diastolic BP<80 mmHg) was observed in 21.6% of men and 29.6% of women.*"

Results: The reporting of regression analyses from Tables 4 and 5 should focus on the adjusted values as these are the interesting bits not the unadjusted.

Our response: we have modified the section which now reads:

"*Unadjusted and adjusted odd ratios and 95% confidence intervals for the association of prevalent hypertension with potential predictors are shown in Table 3. In multivariable logistic regression models adjusted for age, sex, parental history of hypertension, body mass index and region, the significant predictors of prevalent hypertension were male sex, increasing age, Region, parental history of hypertension, personal history of diabetes, high BMI and high waist circumference (Table 3) . In multivariable models with similar level of adjustment (Table 4), male sex, high BMI and physical inactivity were associated with poor control of hypertension, while being from Regions other than Centre or Littoral was associated with good control among treated patients (Table 4).*"

Conclusions: Please rephrase the first two sentences of the conclusion as they are currently unclear.

Our response: The two sentences have been modified and now read:

"*In conclusion, our study has provided findings that are in line with the high prevalence of hypertension previously reported in urban settings in Africa. The study further suggests that efforts to detect and treat to the targets those with the disease are still below optimal.*"

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1-3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any pre-specified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*7-8*
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	8-9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	8-9

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11
		(*b*) Report category boundaries when continuous variables were categorized	11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.