Medicine®

SYSTEMATIC REVIEW AND META-ANALYSIS

OPEN

Prevalence of Hypertension in Low- and Middle-Income Countries

A Systematic Review and Meta-Analysis

Ahmed M. Sarki, MSc, Chidozie U. Nduka, MD, MPH, Saverio Stranges, MD, PhD, Ngianga-Bakwin Kandala, PhD, and Olalekan A. Uthman, MD, MPH, PhD

Abstract: We aimed to obtain overall and regional estimates of hypertension prevalence, and to examine the pattern of this disease condition across different socio-demographic characteristics in low-and middle-income countries.

We searched electronic databases from inception to August 2015. We included population-based studies that reported hypertension prevalence using the current definition of blood pressure ≥140/90 mm Hg or self-reported use of antihypertensive medication. We used random-effects meta-analyses to pool prevalence estimates of hypertension, overall, by World Bank region and country income group. Meta-regression analyses were performed to explore sources of heterogeneity across the included studies.

A total of 242 studies, comprising data on 1,494,609 adults from 45 countries, met our inclusion criteria. The overall prevalence of hypertension was 32.3% (95% confidence interval [CI] 29.4–35.3), with the Latin America and Caribbean region reporting the highest estimates (39.1%, 95% CI 33.1–45.2). Pooled prevalence estimate was also highest across upper middle income countries (37.8%, 95% CI 35.0–40.6) and lowest across low-income countries (23.1%, 95% CI 20.1–26.2). Prevalence estimates were significantly higher in the elderly (≥65 years) compared with younger adults (<65 years) overall and across the geographical regions; however, there was no significant sex-difference in hypertension prevalence (31.9% vs 30.8%, $P = 0.6$). Persons without formal education (49.0% vs 24.9%, $P < 0.00001$), overweight/obese (46.4% vs 26.3%, $P < 0.00001$), and urban settlers (32.7% vs 25.2%, $P = 0.0005$) were also more likely to be hypertensive, compared with those who were educated, normal weight, and rural settlers respectively.

This study provides contemporary and up-to-date estimates that reflect the significant burden of hypertension in low- and middle-income countries, as well as evidence that hypertension remains a major public health issue across the various socio-demographic subgroups. On average, about 1 in 3 adults in the developing world is hypertensive. The findings of this study will be useful for the design of hypertension screening and treatment programmes in low- and middle-income countries.

(*Medicine* 94(50):e1959)

Abbreviations: BMI = body mass index, CI = confidence interval, LMICs = low- and middle-income countries, MeSH = Medical Subject Heading, mm Hg = millimetres of mercury, PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-analyses, WHO = World Health Organization.

Editor: Leonardo Roever.
Received: July 1, 2015; revised: October 9, 2015; accepted: October 13, 2015.
From the Division of Health Sciences, University of Warwick Medical School, Coventry, UK (AMS, CUN); Family and Youth Health Initiative (FAYOHI), Nigeria (AMS); Department of Population Health, Luxembourg Institute of Health, Luxembourg (SS, N-B K); Warwick-Centre for Applied Health Research and Delivery (WCAHRD), Division of health Sciences, University of Warwick Medical School, Coventry, UK (OAU); and Centre for Applied Health Research and Delivery (CAHRD), Liverpool School of Tropical Medicine, International Health Group, Liverpool, UK (OAU); Department of Mathematics and Information sciences, Faculty of Engineering and Environment, Northumbria University, Newcastle upon Tyne, UK (N-B K).
Correspondence: Ahmed M. Sarki, Division of Health Sciences, University of Warwick Medical School, Coventry CV4 7AL, UK (e-mail: A.M.Sarki@warwick.ac.uk).
Supplemental Digital Content is available for this article.
Authors' Contributions: all authors contributed to the study concept and design. AMS, CN, and OU analyzed and interpreted the data. AMS and CN prepared the first draft of the article. All authors revised it critically and approved final submission.
Funding Statement: CUN acknowledges support from the University of Warwick Chancellor's Scholarship (ID 1160088). OAU acknowledges support from the Marie Curie International Postdoc Fellowship Grant (2012-0064). The funding sources had no role in the design, conduct, and reporting of the study.
The authors have no conflicts of interest to disclose.

ISSN: 0025-7974
DOI: 10.1097/MD.0000000000001959

INTRODUCTION

Hypertension drives the global burden of cardiovascular disease, being widely acknowledged as the most common cardiovascular disorder and number 1 risk factor for mortality.[1–3] The occurrence of hypertension is increasing globally, with projections estimating a 30% increase in prevalence by the year 2025.[4] However, owing to several factors such as the ongoing nutritional transition, increasing trends in sedentary lifestyle, and other modifiable risk factors, and inadequate health care systems, populations in low- and middle-income countries (LMICs) may bear a higher burden of the disease, compared with the global average. Projections estimate that three-quarters of the world's hypertensive population will reside in LMICs within the next decade.[4] However, there is a dearth of evidence providing up-to-date estimates of the occurrence of hypertension and its determinants across the developing regions of the world. The existing systematic reviews have, hitherto, been country-specific,[5] or focused on African populations.[6,7] Therefore, we aimed to fill this gap in the evidence by providing overall and regional estimates of hypertension prevalence across LMICs and to examine the pattern of this disease across different socio-demographic characteristics.

METHODS

Protocol and Registration

The systematic review rational and methods were specified in advance and documented in a protocol, which was published in the PROSPERO register (CRD42013006162).[8]

Eligibility Criteria

We included population-based studies that reported crude prevalence estimates of hypertension in LMICs (see Table 1 for full inclusion and exclusion criteria).

Information Sources and Search Strategy

We searched the following electronic databases from inception to August 2015: EMBASE, Ovid MEDLINE, and the WHO Global Cardiovascular Infobase for relevant articles. The search was conducted using the following medical subject heading (MeSH) terms and keywords: ''hypertension'' OR ''blood pressure'' OR ''hypertens*'' AND ''population-based'' OR ''etiology'' OR ''etiology'' OR ''prevalence'' OR ''epidemiolog*'' AND ''low- and middle-income countries'' OR ''developing countries'' (see Appendix 1 for the MEDLINE search strategy, http://links.lww.com/MD/A543). We also scanned through cross-references of identified primary studies and review articles for eligible studies.

Study Selection

Three reviewers (AMS, CN, and OU) independently evaluated the eligibility of the studies obtained from the literature searches. All articles yielded by the database search were initially screened by their titles and abstracts to obtain studies that met our inclusion criteria. In cases of discrepancies, agreement was reached by consensus and by discussion with a fourth reviewer (SS).

Data Collection Process and Data Items

Three reviewers (AMS, CN, and OU) independently evaluated the methodological quality of each included study and extracted data using a piloted form; discrepancies were resolved by discussion with a fourth reviewer (SS). Data extracted included year of publication, country of origin, study design, sample size, sampling strategy, study period, setting (rural/urban), gender distribution, age group, mean age, body mass index (BMI) category, hypertension prevalence, diagnostic criteria for hypertension, confounders, smoking status, alcohol use, education and employment status. Countries were grouped by region and income according to World Bank[9] development indicators. Age group, gender, BMI category, smoker status, alcohol use, and study setting were coded as dichotomous variables. We defined overweight/obesity as BMI $\geq$ 25 kg/m^2. Total prevalence estimates of hypertension were calculated from studies providing only subgroup estimates. The total mean age in each study was also obtained from reports of this variable measure within subgroups.

Risk of Bias in Included Studies

Methodological quality entailed assessing the risk of bias for each study using a domain-based tool adapted from the Newcastle-Ottawa Scale (see Appendix 2, http://links.lww.com/MD/A543).[10] The risk of bias in each study was classified as low, moderate, high or unclear across the following domains: selection of participants (selection bias), sample size justification (selection bias), outcome measurement (detection bias), and confounding adjustment.

Ethical Approval

Being a systematic review of published literature, no ethical approval was required for conducting this study. However, we ensured that all studies included in our review provided evidence of ethical approval and informed consent from all patients or respondents where required.

Statistical Analysis

We stabilized the raw proportions of participants with hypertension from each study using the Freeman–Tukey variant of the arcsine square root transformed proportion[11] suitable for pooling proportions (see Appendix 3, http://links.lww.com/MD/A543). In performing the meta-analyses, we used the DerSimonian–Laird random-effects model[12] due to anticipated variations in study population, methodologies, and stage of epidemic transition. We assessed heterogeneity among studies by inspecting the forest plots and using the chi squared test for heterogeneity with a 10% level of statistical significance, and using the I^2 statistic, where we interpreted a value of 50% as representing moderate heterogeneity.[13,14] We assessed the potential for publication bias by evaluating funnel plot asymmetry using Egger's test for regression asymmetry.[15] Where there was evidence of publication bias, we used the ''trim and fill'' analysis of Duval and Tweedie[16] to examine the potential impact of missed or unpublished studies on the pooled estimates of hypertension prevalence.

The potential modifying effects of various study-level variables on the overall prevalence of hypertension were

TABLE 1. Eligibility criteria

	Inclusion	Exclusion
Population	Adults (18 years and above)	Adolescents and children
Outcome	Hypertension prevalence reported or deducible from subgroup estimates	Hypertension prevalence not reported
	Hypertension assessed as: BP $\geq$ 140/90 mm Hg, use of antihypertensive drugs, self-reported physician-diagnosed cases	Pulmonary hypertension Hypertension assessed as: BP $\geq$ 160/95 mm Hg or other assessment criteria
Study	All population-based studies, regardless of the design: cross-sectional studies, cohort studies, randomized controlled trials	Hospital-based studies Policy reports Expert reviews Studies not published in English language
	Studies published in English language	
Study location	Low- and middle-income countries	High-income countries

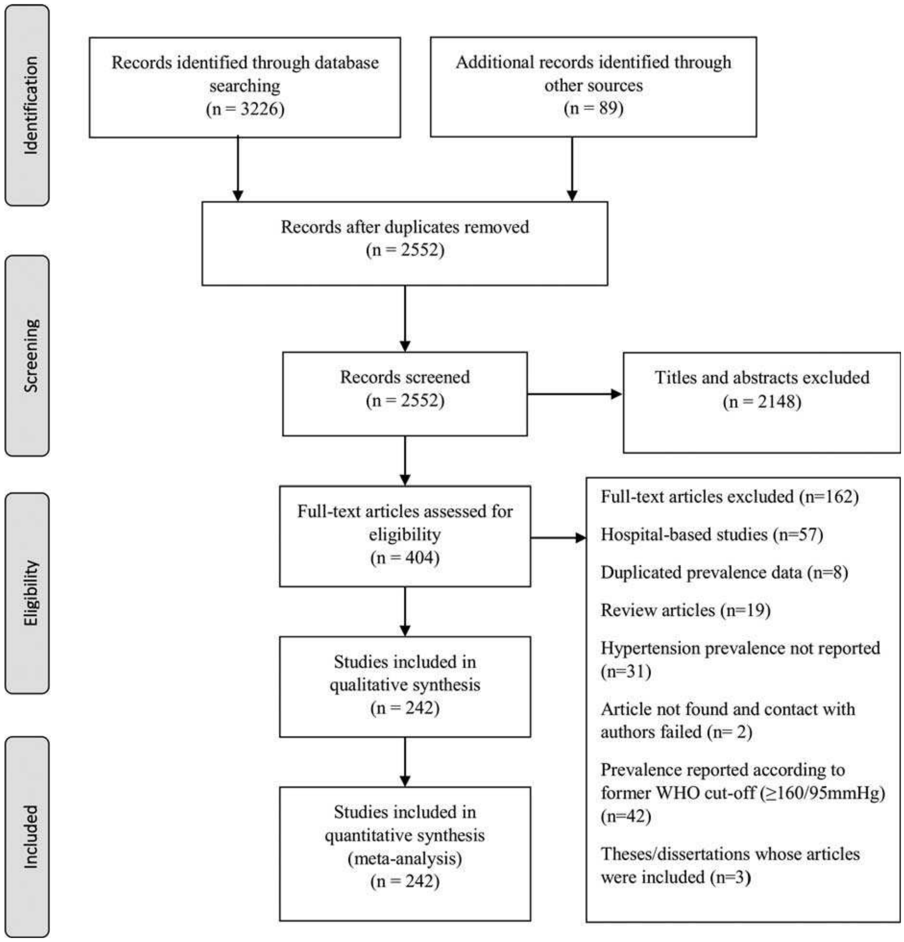

FIGURE 1. PRISMA flow diagram showing study selection.

explored using subgroup and univariable random-effects meta-regression analyses: year of publication, age group, gender, education status, employment status, smoker status, alcohol use, overweight/obesity, country income groups,[9] and study settings (urban, rural or mixed).

Hypertension prevalence estimates were reported with 95% confidence intervals (CIs). All P values were exact (except where $P < 0.0001$)[14] and 2-tailed; $P < 0.05$ was considered statistically significant. Analyses were conducted using Stata version 12 for Windows (Stata Corp, College Station, TX) using the ''metaprop'' rountine.[17] This systematic review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (http://www.prisma-statement.org).[18] The PRISMA checklist is provided in Appendix 4, http://links.lww.com/MD/A543.

RESULTS

Study Flow and Characteristics

Figure 1 shows the study selection flow. The literature search yielded 3315 articles. After an initial screening process, 404 articles were selected for critical reading. One hundred and sixty two (162) studies were excluded for not meeting the selection criteria, leaving 242 studies (from 239 publications),[19–254] which we considered eligible for inclusion in this systematic review. Table 2 and eTables 1–6, http://links.lww.com/MD/A543 summarize the characteristics of the included studies by region.

Studies comprised data on 1,494,609 participants (52% females) from 45 countries (Table S7, http://links.lww.com/MD/A543). Most of the studies were conducted in India (n = 50 studies; 20.7%), Brazil (n = 26; 10.7%), Nigeria (n = 25; 10.3%), and China (n = 22; 9.1%). Although a third of the included studies (n = 74; 30.6%) originated from sub-Saharan African countries, all 6 regions, including East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, South Asia, and sub-Saharan Africa were represented in our review. Figure 2 showcases country-wide differences among the 45 countries included in this study.

All articles were population-based observational studies. Hypertension was diagnosed as blood pressure (BP) ≥140/90 mm Hg in all but 3 studies where assessment was based on self-reported physician diagnoses alone.[58,62,70] The mean age overall was 45.9 ± 12.1 years with participants from Europe and Central Asia being the youngest (35.7 ± 11.4 years) and those from East Asia and Pacific being the oldest (51.7 ± 9.1 years). Participants in the Middle East and North Africa had the highest estimates of combined overweight/obesity (56.8% [95% CI 40.6–73.2]), whereas the lowest rates were found in the South Asia region (29.0% [95% CI 18.4–41.0]).

TABLE 2. Characteristics of Included Studies by Regions

Characteristics	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa
Mean age ± SD (y)	51.7 ± 9.1	35.7 ± 11.4	50.5 ± 11.6	49.3 ± 12.1	42.3 ± 11.0	41.0 ± 13.1
Males (%) (95% CI)	49.1 (37.2–60.4)	37.9 (38.6–46.5)	43.4 (38.9–47.1)	44.0 (40.0–47.3)	48.9 (40.7–56.1)	44.2 (42.0–46.0)
Smokers (%) (95% CI)	30.8 (22.0–40.0)	20.3 (7.7–37.0)	21.0 (17.8–24.2)	7.0 (1.4–14.7)	27.0 (15.0–40.3)	10.7 (7.2–15.5)
Alcohol users (%) (95% CI)	26.2 (21.4–31.0)	24.0 (23.1–25.0)	19.8 (13.0–28.7)	2.6 (2.5–2.9)	33.0 (17.6–48.8)	32.8 (24.5–41.7)
Overweight/obese (%) (95% CI)	29.0 (18.4–41.0)	52.3 (24.9–79.1)	46.8 (41.0–53.9)	56.8 (40.6–73.2)	32.0 (26.9–38.0)	30.4 (24.2–36.3)
Noneducated (%) (95% CI)	32.1 (19.0–46.9)	15.7 (14.7–16.7)	23.6 (13.9–37.0)	23.2 (22.8–24.3)	38.0 (31.0–45.2)	28.1 (19.4–36.7)

CI = confidence intervals, SD = standard deviation, y = years.

Risk of Bias of Included Studies

Summary of risk of bias assessment for each study is shown in Appendix 5, http://links.lww.com/MD/A543. Overall, 111 studies (46%) were assessed as having low risk of selection bias within the sampling domain, having selected participants randomly. Based on sample size justification, the risk of selection bias was also assessed as low in 73 studies (30%). Detection bias was low in 193 studies (80%) reporting the use of a validated tool for measuring blood pressure. However, assessment of hypertension was not blind in any of the included studies, consequently resulting in high risk of detection bias within this domain in all 242 studies.

Pooled Prevalence by Geographical Regions

The country-specific prevalence of hypertension is shown in Figure 2. All 242 studies reported the crude prevalence of hypertension and were included in meta-analysis. The reported hypertension ranged from 2.5% (95% CI 1.9–3.2)[107] to 90% (95% CI 89.9–90.2)[29] (both studies in India). The pooled hypertension prevalence for all studies yielded an estimate of 32.3% (95% CI 29.4–35.3). The I^2 statistic was 99.9%, indicating substantial heterogeneity across the included studies. The contour-enhanced funnel plot for assessing publication bias is shown in eFigure 1, http://links.lww.com/MD/A543. The funnel plot appears symmetric and shows no evidence of publication bias.

The prevalence estimates of hypertension across regions, country income groups, and settings are shown in Figure 3. Subgroup analysis by region showed the highest prevalence estimate of hypertension in the Latin America and Caribbean region (39.1% [95% CI 33.1–45.2]) (eFigure 2, http://links.lww.com/MD/A543)[29,35,46–73] whereas the Middle East and North Africa region had the lowest prevalence (26.9% [95% CI 19.3–35.3]) (eFigure 3, http://links.lww.com/MD/A543).[74–81]

The East Asia and Pacific region (35.7% [95% CI 32.2–39.4]) (eFigure 4, http://links.lww.com/MD/A543)[19–37] and Europe and Central Asian region (32.0% [95% CI 28.0–37.0]) were second and third respectively to the Americas (eFigure 4, http://links.lww.com/MD/A543 and eFigure 5, http://links.lww.com/MD/A543). Prevalence estimates for the Sub-Saharan Africa[38–45] and South Asia[29,35,82–108] regions are shown respectively in eFigure 6, http://links.lww.com/MD/A543 and eFigure 7, http://links.lww.com/MD/A543.

Pooled Prevalence by Country Income Groups

Upper middle income countries had a higher prevalence of hypertension (37.8% [95% CI 35.0–40.6]), compared with lower middle income (31.1% [95% CI 26.1–36.4]) and low-income countries (23.1% [95% CI 20.1–26.2]) (eFigures 8–10, http://links.lww.com/MD/A543). Hypertension prevalence was also higher among populations in urban settings (32.7% [95% CI 30.4–35.0]), compared with populations in rural settings (25.2% [95% CI 20.9–29.8]) (eFigures 11 and 12, http://links.lww.com/MD/A543).[29–31,40,42,76,78,80,99,111,113,121,128,131, 135,136,140,146]

Pooled Prevalence by Participants' Socio-Demographic Characteristics

We summarized the patterns of hypertension across different socio-demographic characteristics for each region in Table 3. In all regions except the Middle East and North Africa region, where no data on hypertension prevalence was reported for the elderly (≥65 years), the proportion of hypertension was substantially higher among adults ≥ 65 years, compared to

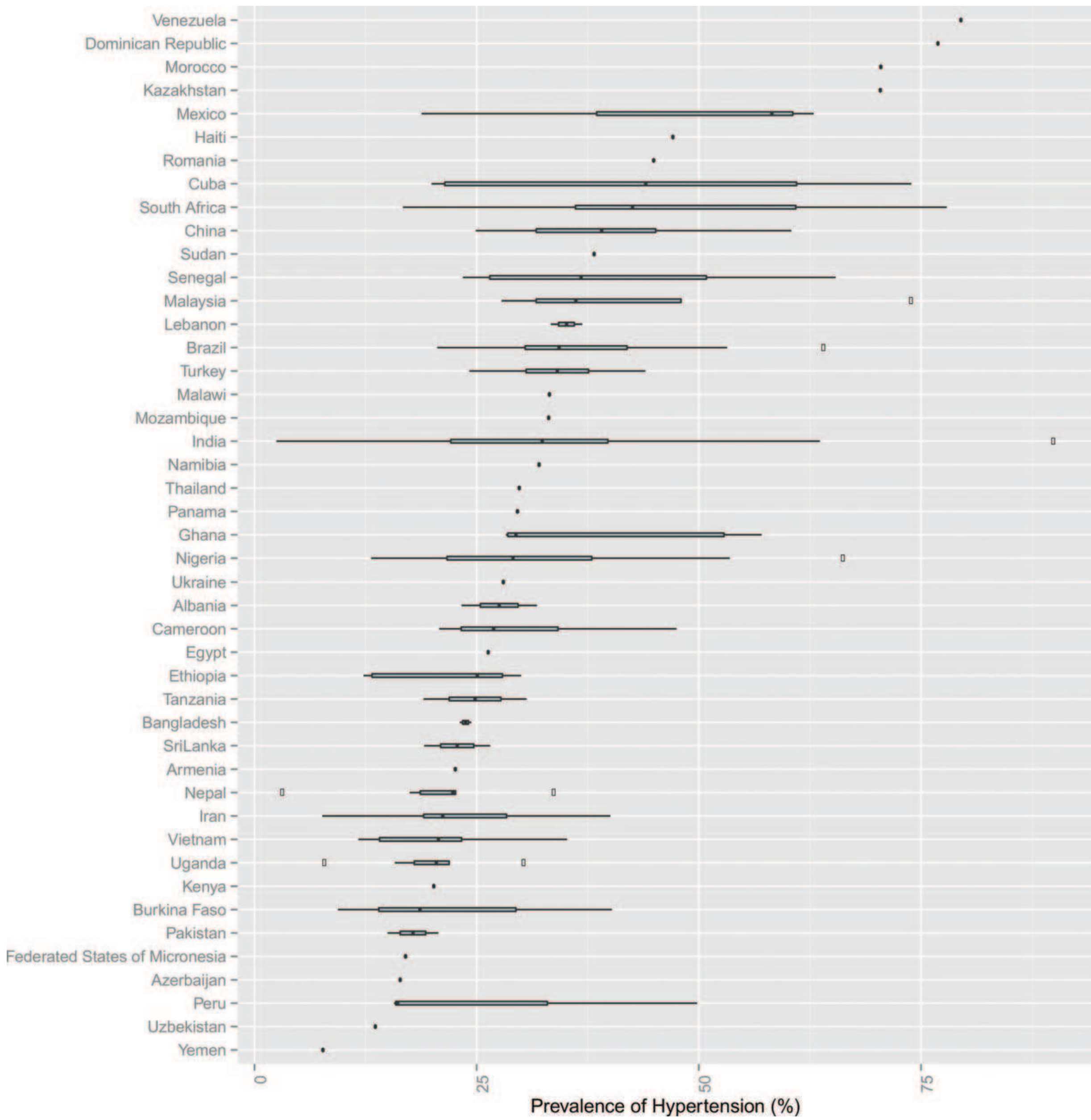

FIGURE 2. Prevalence estimates of hypertension by region, income group, and study setting.

adults < 65 years (mean prevalence 65.6% [95% CI 53.6–75.0] vs 28.7% [95% CI 21.8–37.6], $P < 0.00001$).[22,23,30,31,40,42,46,55,56,59,61,62,65,66,69,70,84,90,91,95,97,99,101,113,117,121,122,128,131,134–136,146,147] Nonetheless, hypertension prevalence in the Middle East and North Africa region was reportedly high among adults < 65 years (32.4% [95% CI 18.7–47.9]).[78,79]

Although prevalence of hypertension in men overall (33%) was slightly higher compared with women (31.2%), this difference was not statistically significant ($P = 0.76$). Additionally, no significant sex-deference in hypertension prevalence was observed by region.

We found higher proportions of hypertension among nonsmokers compared to smokers in Europe and Central Asia, Latin America and Caribbean, and Middle East and North Africa regions. Whereas the proportions of hypertension was higher amongst smokers compared to nonsmokers in East Asia and Pacific, South Asia, and Sub-Saharan Africa regions. Alcohol use data was not reported in any study originating from countries in the Middle East and North Africa or the East Asia and Pacific regions. With the exception of the sub-Saharan Africa region, hypertension rates were comparable between nondrinkers and current drinkers; nondrinkers had a substantially higher proportion of hypertension compared to current drinkers in sub-Saharan Africa (32.0% [95% CI 20.9–44.2] vs 21.7% [95% CI 14.6–29.6], $P < 0.00001$).[113,121,131,135,136,140] Importantly, hypertension rates were consistently higher among overweight/obese participants, compared to normal weight persons across all regions (mean prevalence 46.4% [95% CI

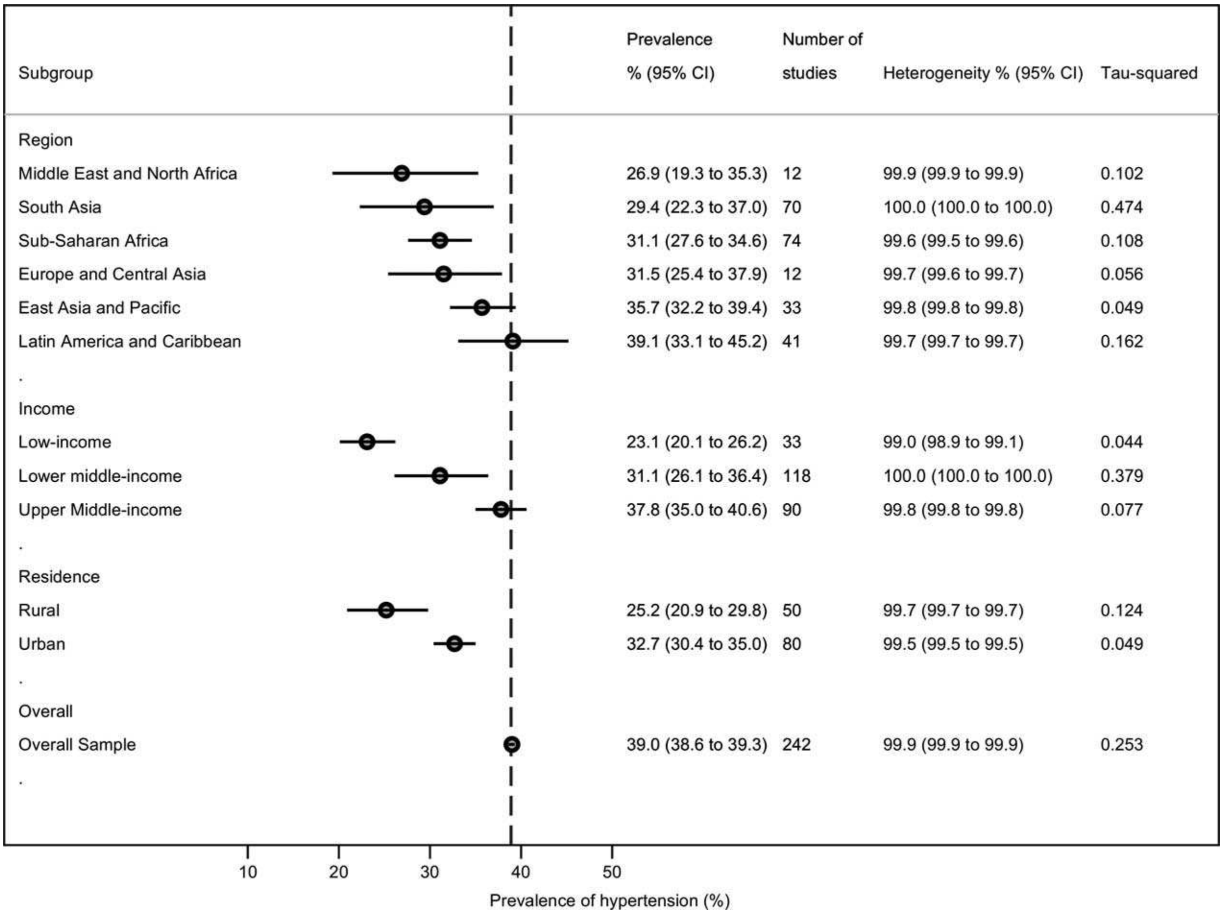

FIGURE 3. Country-specific hypertension prevalence.

33.1–60.7] vs 26.3% [95% CI 15.8–37.8], $P < 0.00001$).[30,33,41,44,47,55,56,61,62,65,66,69,78,85,90,97,99,106,113,117,128,131,134–136,140]

With respect to study setting, prevalence estimates of hypertension were higher in urban communities, compared to participants in rural settings in the Latin America and Caribbean region (51.2% [95% CI 30.1–72.0] vs 42.8% [95% CI 26.1–60.4], $P = 0.00017$),[29] East Asia and Pacific (51.2% [32.8–69.5] vs 47.5% [25.5–70.1], $P < 0.00001$), South Asia (35.9% [95% CI 19.1–54.7] vs 28.0% [95% CI 18.8–38.2], $P < 0.00001$),[29,99] and Sub-Saharan Africa (34.9% [95% CI 23.0–47.8] vs 29.9% [95% CI 22.6–37.9], $P = 0.017$).[111,113,121,128,131,135,136,140,146]

Hypertension rates were also generally higher among the noneducated, compared to participants with a primary education (mean prevalence 50.2% [95% CI 30.4 – 69.3] vs 36.3% [95% CI 23.7–50.4], $P < 0.00001$) and participants with a secondary or tertiary education (mean prevalence 25.0% [95% CI 18.8 – 31.9], $P < 0.00001$).[22,30,31,33,40,41,44,47,55,56,61,65,66,69,70,76,79,81,97,99,106,113,117,121,128,131,134,136,140,146,147]

Factors Associated With the Overall Hypertension Prevalence

The results of the meta-regression analyses showed that age (coefficient + 0.04 [95% CI 0.03–0.05], $P < 0.0001$) (Fig. 4), overweight/obesity (coefficient + 0.02 [95% CI 0.01–0.03] $P = 0.001$) (Fig. 5), and educational status (coefficient + 0.01 [95% CI 0.001–0.02] $P = 0.049$) (Fig. 6) accounted for significant heterogeneity in hypertension prevalence between studies. Given that <50% of the included studies had a low risk of sampling bias, we performed meta-regression analysis to determine if the observed heterogeneity in hypertension prevalence was partly influenced by variations in population sampling between studies; our analysis showed no statistically significant effect (coefficient + 0.11 [95% CI −0.04–0.26], $P = 0.14$).

DISCUSSION

Main Findings

To our knowledge, this is the first systematic review on hypertension prevalence and its socio-demographic patterning in the developing world. Our review suggests that hypertension remains an important public health problem in LMICs, with 1 in 3 persons affected by the disease. Our findings also suggest that older age and increased body weight may be consistent predictors of hypertension across LMICs, given that prevalence estimates of hypertension were substantially higher in the elderly, compared with younger adults, and in overweight/obese persons, compared with normal weight persons. Lower educational status was also found to be associated with a high

TABLE 3. Prevalence Estimates of Hypertension by Region Across Socio-demographic Characteristics also Showing Risk of Bias in Included Studies

Characteristics	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa
Region prevalence	35.7 (32.2–39.4)	31.5 (25.4–37.9)	39.1 (33.1–45.2)	26.9 (19.3–35.3)	29.4 (22.3–37.0)	31.1 (27.6–34.6)
Age group						
18–64 y	23.9 (17.4–30.9)*	39.0 (26.0–52.8)*	30.3 (25.1–35.8)*	32.4 (18.7–47.9)	26.1 (20.3–32.3)*	24.4 (20.0–36.0)*
Elderly (≥65 y)	76.5 (61.0–81.0)	78.6 (71.2–85.1)	58.9 (52.7–65.0)	–	53.2 (33.9–72.0)	61.0 (49.3–72.1)
Gender						
Male	35.5 (28.2–43.1)	28.5 (22.8–34.5)	36.3 (31.2–41.7)	28.3 (20.1–37.2)	35.4 (17.9–55.2)	33.8 (28.7–39.2)
Female	30.6 (21.3–40.7)	27.0 (20.6–33.9)	39.6 (34.1–45.2)	27.1 (18.7–36.4)	29.4 (24.3–34.8)	33.4 (27.3–39.7)
Smoker status						
Nonsmoker	20.0 (18.1–22.0)*	30.7 (16.4–47.2)*	40.2 (35.0–45.4)	48.0 (7.7–89.9)*	27.7 (15.4–41.9)*	25.7 (22.6–29.0)
Smoker	32.0 (28.7–35.4)	20.9 (9.6–35.0)	38.3 (30.5–46.4)	23.1 (11.3–37.4)	36.0 (27.8–44.6)	23.9 (18.1–30.3)
Alcohol use						
Nondrinkers	–	28.4 (13.7–45.9)	35.9 (29.5–42.7)	–	28.0 (18.8–38.2)	32.0 (20.9–44.2)*
Current drinkers	–	29.2 (14.8–46.2)	34.8 (29.9–39.8)	–	32.1 (18.7–47.1)	21.7 (14.6–29.6)
Study setting						
Rural	47.5 (25.5–70.1)[a]	29.8 (3.3–68.4)[a]	42.8 (26.1–60.4)[b]	15.8 (8.2–25.4)	28.0 (19.2–37.8)*	29.9 (22.6–37.9)[c]
Urban	51.2 (32.8–69.5)	26.4 (4.9–56.9)	51.2 (30.1–72.0)	15.4 (8.3–24.3)	35.9 (19.1–54.7)	34.9 (23.0–47.8)
BMI category						
Normal weight	21.7 (20.0–23.5)*	18.4 (12.0–25.8)*	28.0 (23.2–32.9)*	46.7 (6.6–89.5)*	23.3 (15.8–31.8)*	22.6 (19.1–26.3)*
Overweight/obese	45.8 (37.3–54.4)	51.8 (32.9–70.5)	48.8 (44.1–53.4)	58.3 (20.5–91.2)	40.4 (31.1–50.1)	41.1 (35.5–46.9)
Education						
No education	65.4 (43.8–84.2)*	57.2 (22.7–88.2)*	50.4 (37.5–63.2)*	48.3 (26.7–70.2)*	31.1 (16.7–47.8)	48.5 (35.2–61.9)*
Primary	47.8 (21.1–75.2)	26.1 (7.0–51.8)	45.2 (37.7–52.8)	25.7 (16.6–36.1)	39.4 (33.1–45.8)	33.4 (26.6–40.5)
≥Secondary	29.5 (17.4–43.3)	21.4 (17.1–26.0)	25.7 (23.2–28.3)	18.6 (13.8–23.9)	27.9 (21.2–35.1)	27.0 (20.1–34.5)

BMI = body mass index, y = years.

Hypertension prevalence was reported with 95% confidence intervals. * = ($P < 0.00001$), a = ($P = 0.05$), b = ($P = 0.0002$), c = ($P = 0.02$). *P*-values for Education are as for comparisons between ''no education'' and ''secondary and above.'' $P > 0.05$ for all other comparisons.

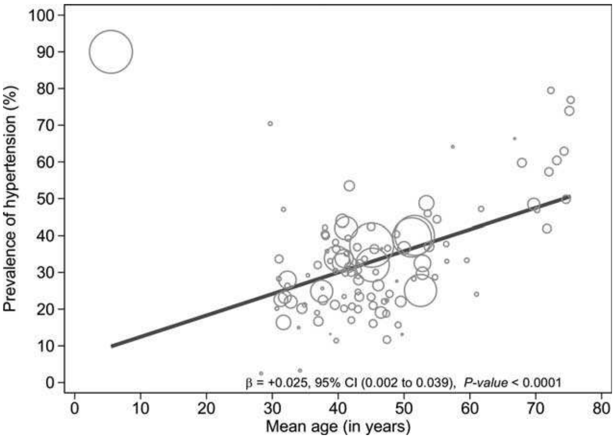

FIGURE 4. Meta-regression of hypertension against age.

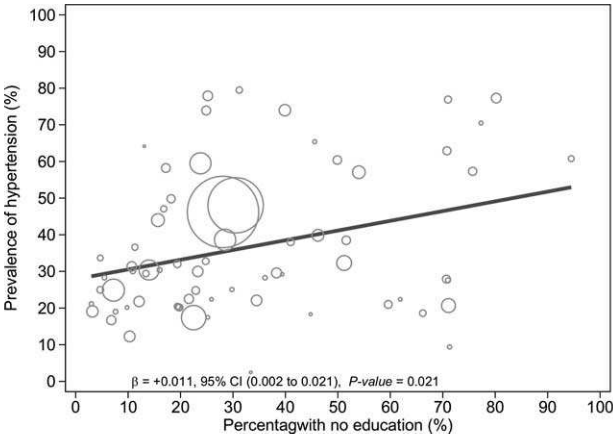

FIGURE 6. Meta-regression of hypertension against education.

prevalence of hypertension; however, this association was not consistent across counties and geographical regions.

Our results correspond to Kearney and colleagues[4] who found hypertension prevalence to be highest among Latin America and Caribbean populations, compared to other regions, based on data collected prior to 2001. This broadly suggests that hypertension prevalence estimates in the Latin America and Caribbean region may have driven the burden of the disease in the developing world for more than a decade. Hypertension rates were more likely to be higher in upper middle income countries than in lower middle income countries, and the latter more likely to be higher compared to low-income countries. We hypothesize that a temporal relationship exists between increasing levels of affluence and urbanization and raised blood pressure. This plausibly accounts for the graded rise in hypertension rates, which is characteristic of the epidemiological transition within urban societies in resource-limited settings.[241,242] The higher prevalence of hypertension in urban settings compared to rural settings, as shown in our study and in previous reviews,[6,243] are also in accordance with this hypothesis.

Our findings also suggest that hypertension may be associated with socio-economic inequalities in LMICs: prevalence estimates for hypertension were inversely proportional to educational attainment, resulting in a downward socioeconomic gradient for hypertension. Evidence of health inequalities associated with hypertension in LMICs are not uncommon.[244,245] Although men and women hypertension prevalence estimates were comparable overall, the slightly higher prevalence in men than women observed in our results are consistent with previous systematic reviews.[6,243] This slight difference may be explained by evidence confirming male predilection for cardiovascular problems in the middle-age group, which attenuates in older adults as exemplified by an increased risk of cardiovascular diseases among post-menopausal women.[244,245] Nonetheless, we observed a significant direct association between mean age and hypertension prevalence, which may be attributed to age-related structural changes in blood vessels which potentially cause narrowing of the vascular lumen, and consequently increasing blood pressure, as have been reported in previous studies.[246–248] This hypothesis may also explain the unusually high prevalence estimates of hypertension ($> 70\%$) observed in a few of the included studies,[30,32,232] given that the sampled population in these studies comprised mostly of the elderly.

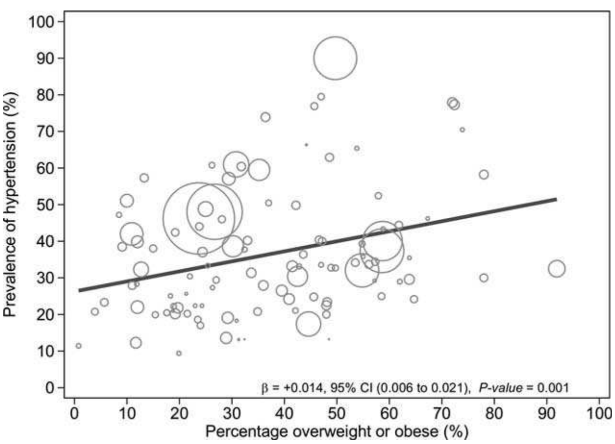

FIGURE 5. Meta-regression of hypertension prevalence against overweight/obesity.

Our review confirms that smoking is an independent risk factor for hypertension in Asian communities,[249,250] given that smokers were more likely than nonsmokers to be hypertensive in the Asia regions alone.

Nevertheless, the higher proportions of hypertension among nonsmokers compared to smokers in the non-Asia regions may be attributed to smokers erroneously self-reporting their smoker status as nonsmokers in some of the included studies. Whereas this argument may account for the higher prevalence of hypertension among nondrinkers, compared to drinkers, in the sub-Saharan Africa region, it is also important to emphasize that nonsmokers and nondrinkers alike may engage in other harmful behaviors known to increase the risk of hypertension. Obviously, we cannot rule out the potential of reverse causation in cross-sectional studies, as it is possible that both nonsmokers and nondrinkers may have quit these harmful behaviors due to underlying medical conditions.[251] However, it is important to state that we were not able to separate never smokers and never drinkers from exsmokers and exdrinkers in most of the included studies.

The association between combined overweight/obesity and hypertension shown in our results exemplify the role of excess body weight in hypertension prevalence, which has been long recognized and consistent across numerous observational and trial data.[252–256]

Study Limitations and Strengths

We acknowledge that the overall quality of the included studies was moderate at best, especially given that more than a third of the studies (39%) were assessed as having high risk of sampling bias. However, as shown using meta-regression analysis, we emphasize that the high rates of sampling bias had no undue impact on the overall hypertension prevalence.

High amounts of heterogeneity across the included studies were another limitation of our study. Prevalence estimates from different regions were pooled in this meta-analysis, and as expected, high heterogeneity between studies was found in the meta-analyses. A substantial amount of the heterogeneity across studies was explained by such factors as differences in population characteristics and study methodologies. Nonetheless, as affirmed by previous evidence, meta-analyses are the preferred options to narrative syntheses for interpreting the results in a review, even in spite of the presence of a considerable amount of heterogeneity.[257] Heterogeneity appeared to be the norm rather than exception in published meta-analyses of observational studies, in which case, it should be expected and quantified appropriately.[258] Although we found some evidence of publication bias, it has been documented that tests of publication bias may lead to false-positive results in the presence of significant heterogeneity.[257,259] Nonetheless, the ''trim and fill'' analysis revealed that the presence of publication bias had no significant impact on the overall prevalence of hypertension. Although we might have missed some potentially relevant studies; however, this systematic review arguably constitutes the largest study on hypertension prevalence in the resource-limited settings, comprising >1 million participants. In addition, we speculate that nonsmokers and nondrinkers may potentially be at risk of hypertension due to other health-damaging behaviors; our study therefore highlights the importance of expatiating on other lifestyle variables as potential correlates of hypertension and other cardiovascular conditions. For example, we were not able to examine the potential impact of differential dietary patterns and dietary salt intake on the observed variations in hypertension prevalence across countries. It is likely that differences in average dietary salt intake at the population level may contribute to some of the observed variations in hypertension prevalence across countries and world regions.[259–261]

In spite of the aforementioned limitations, the review's strengths are important. We conducted comprehensive searches of databases to ensure that all relevant publications were identified. We also reduced potential bias in the conduct of this review by having the authors independently scan through the search output and extract the data. In addition, there was reasonable coverage of evidence for most geographic regions, such as South Asia and sub-Saharan Africa; these regions were well represented by a sufficient number of studies with large sample size, which allows for generalizability of the results across these geographic regions.

Implications of the Results

The elderly, overweight/obese, noneducated and urban settlers present opportunities for targeted health promotion and preventive interventions in LMICs. Given the high burden of infectious diseases in these countries, it might be economically justified to implement intervention programs for hypertension in higher-risk populations alone. However, the occurrence of hypertension in the general population remains unacceptably high, which poses an ethical dilemma to relying on high-risk strategies only in these settings; countries in the Middle East and North Africa region may even not have sufficient evidence to implement public health interventions in certain high-risk populations such as the elderly.

Health inequalities associated with hypertension have been recognized as an important public health issue in low- and middle-income countries.[244,245,262] Addressing the wider social determinants of the disease is therefore crucial to its control in these countries. Failure to address these issues portends additional threats to the sustainability of public health infrastructure, especially alongside the prevailing effects of infectious disease epidemics.

Population-wide strategies such as reduction in dietary salt intake from processed foods are warranted in these low-resource settings, because they have been proven to be cost-effective means to shift blood pressure distribution at the population level, thus reducing the burden of cardiovascular disease associated with the epidemic of hypertension.[263–268] Specifically, population-wide salt reduction through legislation, voluntary agreements with food industries and mass media campaigns are evidence-based cost-effective strategies for reducing hypertension prevalence in low- and middle-income countries, potentially preventing millions of years lost to the disease as a result of ill-health, disability or premature death.[269] The absence of studies targeting the elderly in the Middle East and North Africa region also emphasizes the need for further research into resident high-risk subgroups. Hypertension among the elderly is likely to be a significant public health problem in the region considering that prevalence estimates in the young and middle-age are also high.

In conclusion, this study provides contemporary and up-to-date estimates that reflect the significant burden of hypertension and evidence that hypertension remains a major public health issue in LMICs. On average, about one-third of the adult population in these countries are hypertensive. However, this evidence originates from studies limited by high risk of selection bias and substantial between-study variations in the results. Nonetheless, we provide the most comprehensive evidence and first pooled analyses on hypertension prevalence in the developing world. There is a need for studies to accurately predict future trends of hypertension prevalence estimates in low- and middle-income countries. Additionally, future studies should explore alternative techniques to address heterogeneity, such as disease mapping or hierarchical modeling. The findings of this study would be useful for the design of hypertension screening and treatment programs in LMICs.

REFERENCES

1. Mathers C, Stevens G, Mascarenhas M. Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks. Geneva: World Health Organization; 2009.
2. World Heart Federation. 2015. Cardiovascular disease risk factors. [online] Available at: http://www.world-heart-federation.org/cardiovascular-health/cardiovascular-disease-risk-factors/.(Accessed 18/05/2015).
3. World Health Organization. 2015. Top ten causes of death. [online] Available at: http://www.who.int/mediacentre/factsheets/fs310/en/.(Accessed 17/05/2015).
4. Kearney PM, Whelton M, Reynolds K, et al. Global burden of hypertension: analysis of worldwide data. *Lancet*. 2005;365:217–223.
5. Picon RV, Fuchs FD, Moreira LB, et al. Prevalence of hypertension among elderly persons in urban Brazil: a systematic review with meta-analysis. *Am J Hypertens*. 2013;26:541–548.

6. Addo J, Smeeth L, Leon DA. Hypertension in sub-Saharan Africa: a systematic review. *Hypertension.* 2007;50:1012–1018.
7. Adeloye D, Basquill C. Estimating the prevalence and awareness rates of hypertension in Africa: a systematic analysis. *PLoS ONE.* 2014;9:1–17.
8. Sarki AM, Uthman OA, Kandala N-B, Stranges S, Nduka C. Prevalence of hypertension in low-and middle-income countries: a systematic review. PROSPERO 2013: CRD42013006162. [online] Available at: http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID = CRD42013006162.(Accessed 12/05/2015).
9. World Bank Countries and Economies. Geneva: The World Bank Group; 2014.
10. Wells GA, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: Ottawa Hospital Research Institute; 2014.
11. Miller JJ. The Inverse of the Freeman-Tukey double arcsine transformation. *Am Stat.* 1978;32:138.
12. Dersimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials.* 1986;7:177–188.
13. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med.* 2002;21:1539–1558.
14. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ.* 2003;327:557–560.
15. Egger M, Davey SG, Schneider M, et al. Bias in meta-analysis detected by a simple, graphical test. *BMJ.* 1997;315:629–634.
16. Duval S, Tweedie R. A non-parametric ''Trim and Fill'' method of accounting for publication bias in meta-analysis. *J Am Stat Ass.* 2000;95:89–98.
17. Nyaga VN, Arbyn M, Aerts M. Metaprop: a Stata command to perform meta-analysis of binomial data. *Arch Public Health.* 2014;72:39.
18. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ.* 2009;339:b2700.
19. Shmulewitz D, Auerbach SB, Lehner T, et al. Epidemiology and factor analysis of obesity, type II diabetes, hypertension, and dyslipidemia (syndrome X) on the Island of Kosrae, Federated States of Micronesia. *Hum Hered.* 2001;51:8–19.
20. Wu L, He Y, Jiang B, et al. Trends in prevalence, awareness, treatment and control of hypertension during 2010 in an urban elderly population of China. *PLoS ONE.* 2015;10:e0132814. doi:101371/journal pone 0132814.
21. Gu D, Reynolds K, Wu X, et al. Prevalence, awareness, treatment, and control of hypertension in China. *Hypertension.* 2002;40: 920–927.
22. Lim TO, Morad Z. Prevalence, awareness, treatment and control of hypertension in the Malaysian adult population: results from the national health and morbidity survey 1996. *Singapore Med J.* 2004;45:20–27.
23. Minh HV, Byass P, Chuc NT, et al. Gender differences in prevalence and socioeconomic determinants of hypertension: findings from the WHO STEPs survey in a rural community of Vietnam. *J Hum Hypertens.* 2006;20:109–115.
24. Rampal L, Rampal S, Azhar MZ, et al. Prevalence, awareness, treatment and control of hypertension in Malaysia: a national study of 16,440 subjects. *Public Health.* 2008;122:11–18.
25. Sun Z, Zheng L, Xu C, et al. Prevalence of prehypertension, hypertension and, associated risk factors in Mongolian and Han Chinese populations in Northeast China. *Int J Cardiol.* 2008;128:250–254.
26. Zhang X, Zhu M, Dib HH, et al. Knowledge, awareness, behaviour (KAB) and control of hypertension among urban elderly in Western China. *Int J Cardiol.* 2009;137:250–254.
27. Lee S-A, Cai H, Yang G, et al. Dietary patterns and blood pressure among middle-aged and elderly Chinese men in Shanghai. *Br J Nutri.* 2010;104:265–275.
28. Swaddiwudhipong W, Mahasakpan P, Limpatanachote P, et al. Correlations of urinary cadmium with hypertension and diabetes in persons living in cadmium-contaminated villages in north-western Thailand: a population study. *Environ Res.* 2010;110:612–616.
29. Thuy AB, Blizzard L, Schmidt MD, et al. The association between smoking and hypertension in a population-based sample of Vietnamese men. *J Hypertens.* 2010;28:245–250.
30. Prince MJ, Ebrahim S, Acosta D, et al. Hypertension prevalence, awareness, treatment and control among older people in Latin America, India and China: a 10/66 cross-sectional population-based survey. *J Hypertens.* 2012;30:177–187.
31. Ha DA, Goldberg RJ, Allison JJ, et al. Prevalence, awareness, treatment, and control of high blood pressure: a population-based survey in Thai Nguyen, Vietnam. *PLoS ONE.* 2013;8:1–8.
32. Kiau HB, Kaur J, Nainu BM, et al. Prevalence, awareness, treatment and control of hypertension among the elderly: the 2006 National health and morbidity survey III in Malaysia. *Med J Malaysia.* 2013;68:332–337.
33. Amiri M, Majid HA, Hairi FM, et al. Prevalence and determinants of cardiovascular disease risk factors among the residents of urban community housing projects in Malaysia. *BMC Public Health.* 2014;14(Suppl 3):1–9S3.
34. Fan L, Feng SX, Han B, et al. Prevalence awareness, treatment and control of hypertension in Henan Province, China. *Aust J Rural Health.* 2014;22:264–269.
35. Feng XL, Pang M, Beard J. Health system strengthening and hypertension awareness, treatment and control: data from the China Health and Retirement Longitudinal Study. *Bull World Health Organ.* 2014;92:29–41.
36. Lloyd-Sherlock P, Beard J, Minicuci N, et al. Hypertension among older adults in low-and middle-income countries: prevalence, awareness and control. *Int J Epidemiol.* 2014;43:116–128.
37. Nguyen TP, Schuiling-Veninga CC, Nguyen TB, et al. Models to predict the burden of cardiovascular disease risk in a rural mountainous region of Vietnam. *ViHRI.* 2014;3C:87–93.
38. Wang X, Yang F, Bots ML, et al. Prevalence and clustering of cardiovascular risk factors in adults in Northeast China. *Heart Asia.* 2014;6:122–127.
39. Zhao Q, Gu D, Lu F, et al. Blood pressure reactivity to the cold pressure test predicts hypertension among Chinese adults: the GenSalt study. *Am J Hypertens.* 2015. doi:101093/ajh/hpv035.
40. Hou Z, Meng Q, Zhang Y. Hypertension prevalence, awareness, treatment, and control following China's healthcare reform. *Am J Hypertens.* 2015. doi:101093/ajh/hpv125.
41. Chen L, Zong Y, Wei T, et al. Prevalence, awareness, medication, control, and risk factors associated with hypertension in Yi ethnic group aged 50 years and over in rural China: the Yunnan minority eye study. *BMC Public Health.* 2015;15:383.
42. Li G, Hu H, Dong Z, et al. Urban and suburban differences in hypertension trends and self-care: three population-based cross-sectional studies from 2005–201. *PLoS ONE.* 2015;10: e0117999.
43. Wang S, Liu Y, Li F, et al. A novel quantitative body shape score for detecting association between obesity and hypertension in China. *BMC Public Health.* 2015;15:1–9.

44. Guo J1, Zhu YC, Chen YP, et al. The dynamics of hypertension prevalence, awareness, treatment, control and associated factors in Chinese adults: results from CHNS 1991–2011. *J Hypertens.* 2015;33:1688–1696.
45. Li D, Lv J, Liu F, et al. Hypertension burden and control in mainland China: analysis of nationwide data 2003-2012. *Int J Cardiol.* 2015;184:637–644.
46. Gu H, Li W, Yang J, et al. Hypertension prevalence, awareness, treatment and control among Han and four ethnic minorities (Uygur, Hui, Mongolian and Dai) in China. *J Hum Hypertens.* ;29:555–560.
47. Lu K, Ding R, Tang Q, et al. Association between self-reported global sleep status and prevalence of hypertension in Chinese adults: data from the Kailuan community. *Int J Environ Res Public Health.* 2015;12:488–503. doi:103390/ijerph120100488.
48. Ke L, Ho J, Feng J, et al. Prevalence, awareness, treatment and control of hypertension in Macau: results from a cross-sectional epidemiological study in Macau, China. *Am J Hypertens.* 2015;28:159–165.
49. Wei Q, Sun J, Huang J, et al. Prevalence of hypertension and associated risk factors in Dehui City of Jilin Province in China. *J Hum Hypertens.* 2015;29:64–68.
50. Do HT, Geleijinse JM, Le MB, et al. National prevalence and associated risk factors of hypertension and prehypertension among Vietnamese adults. *Am J Hypertens.* 2015;28:89–97.
51. Shapo L, Pomerleau J, McKee M. Epidemiology of hypertension and associated cardiovascular risk factors in a country in transition: a population based survey in Tirana City, Albania. *J Epidemiol Community Health.* 2003;57:734–739.
52. Onal AE, Erbil S, Ozel S, et al. The prevalence of and risk factors for hypertension in adults living in Istanbul. *Blood Press.* 2004;13:31–36.
53. Mishra V, Arnold F, Semenov G, et al. Epidemiology of obesity and hypertension and related risk factors in Uzbekistan. *Eur J Clin Nutr.* 2006;60:1355–1366.
54. Erem C, Hacihasanoglu A, Kocak M, et al. Prevalence of prehypertension and hypertension and associated risk factors among Turkish adults: Trabzon hypertension study. *J Public Health.* 2008;31:47–58.
55. Dorobantu M, Darabont RO, Badila E, et al. Prevalence, awareness, treatment, and control of hypertension in Romania: results of the SEPHAR study. *Int J Hypertens.* 2010. Article ID 970694:1–6.
56. Altun B, Suleymanlar G, Utas C, et al. Prevalence, awareness, treatment and control of hypertension in adults with chronic kidney disease in Turkey: results from the CREDIT study. *Kidney Blood Press Res.* 2012;36:36–46.
57. Dogan N, Toprak D, Demir S. Hypertension prevalence and risk factors among adult population in Afyonkarahisar region: a cross-sectional research. *Anadolu Kardiyol Derg.* 2012;12:47–52.
58. Harhay MO, Harhay JS, Nair MM. Education, household wealth and blood pressure in Albania Armenia, Azerbaijan and Ukraine: findings from the demographic health surveys. *Eur J Int Med.* 2013;24:117–126.
59. Supiyev A, Kossumov A, Utepova L, et al. Prevalence, awareness, treatment and control of arterial hypertension in Astana, Kazakhstan: a cross-sectional study. *Public Health.* 2015:1–6xxx.
60. Ordunez-Garcia PO, Espinosa-Brito AD, Cooper RS, et al. Hypertension in Cuba: evidence of a narrow black-white difference. *J Hum Hypertens.* 1998;12:111–116.
61. Barreto SM, Passos VM, Firmo JO, et al. Hypertension and clustering of cardiovascular risk factors in a community in southeast Brazil—The Bambuí Health and Ageing Study. *Arq Bras Cardiol.* 2001;77:576–581.
62. Freitas OC, Carvalho FR, Neves JM, et al. Prevalence of hypertension in the urban population of Catanduva, in the State of Sao Paulo, Brazil. *Arq Bras Cardiol.* 2001;77:16–21.
63. Lorenzo C, Serrano-Rios M, Martinez-Larrad MT, et al. Prevalence of hypertension in Hispanic and non-Hispanic white populations. *Hypertension.* 2002;39:203–208.
64. Matos AC, Ladeia AM. Assessment of cardiovascular risk factors in a rural community in the Brazilian State of Bahia. *Arq Bras Cardiol.* 2003;81:297–3023.
65. Gus I, Harzheim E, Zaslavsky C, et al. Prevalence, awareness, and control of systemic arterial hypertension in the State of Rio Grande do Sul. *Arquivos Brasileiros de Cardiologia.* 2004;83:429–433.
66. Ordunez P, Munoz LB, Espinosa-Brito A, et al. Ethnicity, education, and blood pressure in Cuba. *Am J Epidemiol.* 2005;162:49–56.
67. Almeida-Pititto B, Gimeno SG, Freire RD, et al. Leptin is not associated independently with hypertension in Japanese-Brazilian women. *Braz J Med Biol Res.* 2006;39:99–105.
68. Jean-Baptiste ED, Larco P, Charles-Larco N, et al. Glucose intolerance and other cardiovascular risk factors in Haiti. Prevalence of diabetes and hypertension in Haiti (PREDIAH). *Diabetes Metab.* 2006;32:443–451.
69. Lessa I, Magalhaes L, Araujo MJ, et al. Arterial hypertension in the adult population of Salvador (BA)—Brazil. *Arq Bras Cardiol.* 2006;87:683–692.
70. Jardim PC, Gondim Mdo R, Monego ET, et al. High blood pressure and some risk factors in a Brazilian capital. *Arq Bras Cardiol.* 2007;88:398–403.
71. Medina-Lezama J, Zea-Diaz H, Morey-Vargas OL, et al. Prevalence and patterns of hypertension in Peruvian Andean Hispanics: the PREVENCION study. *J Am Soc Hypertens.* 2007;1:216–225.
72. Capilheira MF, Santos IS, Azevedo MR, et al. Risk factors for chronic non-communicable diseases and the CARMEN Initiative: a population-based study in the South of Brazil. *Cad Saúde Pública.* 2008;24:2767–2774.
73. Ordunez P, Barcelo A, Bernal JL, et al. Risk factors associated with uncontrolled hypertension: findings from the baseline CARMEN survey in Cienfuegos, Cuba. *J Hypertens.* 2008;26: 663–671.
74. Sparrenberger F, Fuchs SC, Moreira LB, et al. Stressful life events and current psychological distress are associated with self-reported hypertension but not with true hypertension: results from a cross-sectional population-based study. *BMC Public Health.* 2008;8:1–9357.
75. Longo GZ, Neves J, Luciano VM, et al. Prevalence of high blood pressure levels and associated factors among adults in Southern Brazil. *Arq Bras Cardiol.* 2009;93:360–366.
76. Reichert FF, Azevedo MR, Breier A, et al. Physical activity and prevalence of hypertension in a population-based sample of Brazilian adults and elderly. *Prev Med.* 2009;49:200–204.
77. Rodrigues SL, Baldo MP, Mill JG. Association of waist-stature ratio with hypertension and metabolic syndrome: population-based study. *Arq Bras Cardiol.* 2009;95:186–191.
78. Rosario TM, Scala LC, Franca GV, et al. Prevalence, control and treatment of arterial hypertension in Nobres-MT. *Arq Bras Cardiol.* 2009;93:622–628.
79. Diaz ME, Jimenez S, Garcia RG, et al. Overweight, obesity, central adiposity and associated chronic diseases in Cuban adults. *MEDICC Review.* 2009;11:23–28.

80. Cipullo JP, Martin JF, Ciorlia LA, et al. Hypertension prevalence and risk factors in a Brazilian urban population. *Arq Bras Cardiol.* 2010;94:488–494.
81. Nascente FM, Jardim PC, Peixoto Mdo R, et al. Arterial hypertension and its correlation with some risk factors in a small Brazilian town. *Arq Bras Cardiol.* 2010;95:502–509.
82. Hofelmann DA, Antunes JL, Silva DA, et al. Is income area level associated with blood pressure in adults regardless of individual-level characteristics? A multilevel approach. *Health Place.* 2012;18:971–977.
83. Kerkhoff AC, Moreira LB, Fuchs FD, et al. Association between hypertension and musculoskeletal complaints: a population-based study. *J Hypertens.* 2012;30:2112–2117.
84. Lyra R, Silva RS, Montenegro RM, et al. High prevalence of arterial hypertension in a Brazilian Northeast population of low education and income level, and its association with obesity and metabolic syndrome. *Rev Assoc Med Bras.* 2010;58: 209–214.
85. Mendes TA, Goldbaum M, Segri NJ, et al. Factors associated with the prevalence of hypertension and control practices among elderly residents of Sao Paulo city, Brazil. *Cad Saude Publica.* 2013;29:2275–2286.
86. Selem SS, Castro MA, Cesar CL, et al. Validity of self-reported hypertension is inversely associated with the level of education in Brazilian individuals. *Arq Bras Cardiol.* 2013;100:52–59.
87. Silva DA, Petroski EL, Peres MA. Accuracy and measures of association of anthropometric indexes of obesity to identify the presence of hypertension in adults: a population-based study in Southern Brazil. *Eur J Nutr.* 2013;52:237–246.
88. Posso AJ, Borrel JA, Fontes F, et al. High blood pressure in Panama: prevalence, sociodemographic and biologic profile, treatment, and control (STROBE). *Medicine.* 2014;93:1–10.
89. Bernabe-Ortiz A, Carrillo-Larco RM, Gilman RH, et al. CRONICAS Cohort Study Group. *J Epidemiol Community Health.* 2015;0:1–7.
90. Bresan D, Bastos JL, Leite MS. Epidemiology of high blood pressure among the Kaingang people on the Xapecó Indigenous Land in Santa Catarina State, Brazil, 2013. *Cad Saúde Pública.* 2015;31:331–344.
91. de Souza TCF, Perisse ARS, Moura M. Noise exposure and hypertension: investigation of a silent relationship. *BMC Public Health.* 2015;15:328.
92. Unger A, Felzemburgh RD, Synder RE, et al. Hypertension in a Brazilian urban slum population. *J Urban Health.* 2015;92:446–459.
93. Vieira MC, Sperandei S, Reis A. Physical activity overcomes the effects of cumulative work time on hypertension prevalence among Brazilian taxi drivers. *J Sports Med Phys Fitness.* 2015. [Epub ahead of print].
94. Almeida RC, Dias DJ, Deguchi KT, et al. Prevalence and treatment of hypertension in urban and riverside areas in Porto Velho, the Brazilian Amazon. *Postgrad Med.* 2015;127:66–72.
95. Ibrahim MM, Rizk H, Appel LJ, et al. Hypertension prevalence, awareness, treatment, and control in Egypt. *Hypertension.* 1995;26:886–890.
96. Bahrami H, Sadatsafavi M, Pourshams A, et al. Obesity and hypertension in an Iranian cohort study; Iranian women experience higher rates of obesity and hypertension than American women. *BMC Public Health.* 2006;6:1–9158.
97. Azimi-Nezhad M, Ghayour-Mobarhan M, Esmaeili HA, et al. Newly detected hypertension in an Iranian population: an epidemiological study. *Asian Biomed.* 2009;3:653–662.
98. Ramezani MA, Dastanpour M, Eshaghi SR, et al. Determinants of awareness, treatment and control of hypertension in Isfahan, Central Iran. *Arch Med Sci.* 2009;4:523–530.
99. Ebrahimi M, Mansournia MA, Haghdoost AA, et al. Social disparities in prevalence, treatment and control of hypertension in Iran: second national surveillance of risk factors of noncommunicable diseases, 2006. *J Hypertens.* 2010;28:1620–1629.
100. Berraho M, El Achhab Y, Benslimane A, et al. Hypertension and type 2 diabetes: a cross-sectional study in Morocco (EPIDIAM Study). *Pan Afr Med J.* 2012;11:1–952.
101. Modesti PA, Bamoshmoosh M, Rapi S, et al. Relationship between hypertension, diabetes and proteinuria in rural and urban households in Yemen. *J Hum Hypertens.* 2013;27:572–579.
102. Veghari G, Sedaghat M, Maghsodlo S, et al. Impact of literacy on the prevalence, awareness, treatment and control of hypertension in adults in Golestan Province (northern Iran). *Caspian J Intern Med.* 2013;4:580–584.
103. Khalifeh M, Salameh P, Hajje AA, et al. Hypertension in the Lebanese adults: impact on health related quality of life. *J Epidemiol Global Health.* 2015http://dxdoiorg/101016/jjegh 201502003.
104. Matar D, Frangieh AH, Abouassi S, et al. Prevalence, awareness, treatment, and control of hypertension in Lebanon. *J Clin Hypertens.* 2015;17:381–388.
105. Sepanlou SG, Newson RB, Poustchi H, et al. Cardiovascular disease mortality and years of life lost attributable to non-optimal systolic blood pressure and hypertension in northeastern Iran. *Arch Iran Med.* 2015;18:144–152.
106. Yazdanpanah L, Shahbazian H, Shahbazian H, et al. Prevalence, awareness and risk factors of hypertension in southwest of Iran. *J Renal Inj Prev.* 2015;4:51–56.
107. Gupta R, Sharma AK. Prevalence of hypertension and subtypes in an Indian rural population: clinical and electrocardiographic correlates. *J Hum Hypertens.* 1994;8:823–829.
108. Gupta R, Guptha S, Gupta VP, et al. Prevalence and determinants of hypertension in the urban population of Jaipur in western India. *J Hypertens.* 1995;13:1193–1200.
109. Goel NK, Kaur P, Dr PC. Sen Memorial Award —1994. Role of various risk factors in the epidemiology of hypertension in a rural community of Varanasi district. *Indian J Public Health.* 1996;40:71–76.
110. Singh RB, Beegom R, Mehta AS, et al. Prevalence and risk factors of hypertension and age-specific blood pressures in five cities: a study of Indian women. *Int J Cardiol.* 1998;63:165–173.
111. Malhotra P, Kumari S, Kumar R, et al. Prevalence and determinants of hypertension in an un-industrialised rural population of North India. *J Hum Hypertens.* 1999;13:467–472.
112. Gurav RB, Kartikeyan S, Jadhav BS. Biochemical profile of hypertensive individuals in an urban community. *Indian J Med Sci.* 2001;55:663–668.
113. Swami HM, Bhatia V, Gupta M, et al. Population based study of hypertension among elderly in northern India. *Public Health.* 2002;116:45–49.
114. Hazarika NC, Biswas D, Narain K, et al. Hypertension and its risk factors in tea garden workers of Assam. *Natl Med J India.* 2002;15:63–68.
115. Reddy NK, Kumar DN, Rayudu NV, et al. Prevalence of risk factors for coronary atherosclerosis in a cross-sectional population of Andhra Pradesh. *Indian Heart J.* 2002;54:697–701.
116. Gupta R, Gupta VP, Sarna M, et al. Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. *Indian Heart J.* 2002;54:59–66.

117. Bharucha NE, Kuruvilla T. Hypertension in the Parsi community of Bombay: a study on prevalence, awareness and compliance to treatment. *BMC Public Health.* 2003;3:1–61.
118. Deepa R, Shanthirani CS, Pradeepa R, et al. Is the 'Rule of Halves' in hypertension still valid? Evidence from the Chennai Urban Population Study. *JAPI.* 2003;51:153–157.
119. Hazarika NC, Biswas D, Mahanta J. Hypertension in the elderly population of Assam. *J Assoc Phys India.* 2003;51:567–573.
120. Shanthirani CS, Pradeepa R, Deepa R, et al. Prevalence and risk factors of hypertension in a selected south Indian population—The Chennai Urban Population Study. *JAPI.* 2003;51:20–27.
121. Gupta PC, Gupta R, Pednekar MS. Hypertension prevalence and blood pressure trends in 88 653 subjects in Mumbai. *India J Hum Hypertens.* 2004;18:907–910.
122. Hazarika NC, Narain K, Biswas D, et al. Hypertension in the native rural population of Assam. *Natl Med J India.* 2004;17:300–304.
123. Ahmad K, Jafar TH. Prevalence and determinants of blood pressure screening in Pakistan. *J Hypertens.* 2005;23:1979–1984.
124. Das SK, Sanyal K, Basu A. Study of urban community survey in India: growing trend of high prevalence of hypertension in a developing country. *Int J Med Sci.* 2005;2:70–78.
125. Siddiqui H, Anjum Q, Omair A, et al. Risk factors assessment for hypertension in a squatter settlement of Karachi. *JPMA.* 2005;55:390–392.
126. Prabhakaran D, Shah P, Chaturvedi V, et al. Cardiovascular risk factor prevalence among men in a large industry of northern India. *Natl Med J India.* 2005;18:59–65.
127. Thankappan KR, Shah B, Mathur P, et al. Risk factor profile for chronic noncommunicable diseases: results of a community-based study in Kerala, India. *Indian J Med Res.* 2010;131:53–63.
128. Mohan V, Deepa M, Farooq S, et al. Prevalence, awareness and control of hypertension in Chennai—The Chennai Urban Rural Epidemiology Study (CURES-52). *JAPI.* 2007;55:326–332.
129. Vaidya A, Pokharel PK, Nagesh S, et al. War veterans of Nepal and their blood pressure status: a population-based comparative study. *J Hum Hypertens.* 2007;21:900–903.
130. Wijewardene K, Mohideen MR, Mendis S, et al. Prevalence of hypertension, diabetes and obesity: baseline findings of a population based survey in four provinces in Sri Lanka. *Ceylon Med J.* 2005;50:62–70.
131. Reddy KS, Prabhakaran D, Jeemon P, et al. Educational status and cardiovascular risk profile in Indians. *Proc Natl Acad Sci.* 2007;104:16263–16268.
132. Gupta R, Kaul V, Bhagat N, et al. Trends in prevalence of coronary risk factors in an urban Indian population: Jaipur Heart Watch-4. *Indian Heart J.* 2007;59:346–353.
133. Chaturvedi S, Pant M, Yadav G. Hypertension in Delhi: prevalence, awareness, treatment and control. *Trop Doct.* 2007;37:142–145.
134. Agrawal VK, Bhalwar R, Basannar DR. Prevalence and determinants of hypertension in a rural community. *MJAFI.* 2008;64:21–25.
135. Yadav G, Chaturvedi S, Grover VL. Prevalence, awareness, treatment and control of hypertension among the elderly in a resettlement colony of Delhi. *Indian Heart J.* 2008;60:313–317.
136. Kusuma YS, Gupta SK, Pandav CS. Knowledge and perceptions about hypertension among neo- and settled-migrants in Delhi, India. *CVD Prev Control.* 2009;4:119–129.
137. Pednekar MS, Gupta R, Gupta PC. Association of blood pressure and cardiovascular mortality in India: Mumbai cohort study. *Am J Hypertens.* 2009;22:1076–1084.
138. Pednekar MS, Hakama M, Hebert JR, et al. Association of body mass index with all-cause and cause-specific mortality: findings from a prospective cohort study in Mumbai (Bombay), India. *Int J Epidemiol.* 2008;37:524–535.
139. Midha T, Idris M, Saran R, et al. Isolated systolic hypertension and its determinants: a cross-sectional study in the adult population of Lucknow district in north India. *Indian J Community Med.* 2010;35:89–93.
140. Bhardwaj R, Kandoria A, Marwah R, et al. Prevalence, awareness and control of hypertension in rural communities of Himachal Pradesh. *JAPI.* 2010;58:423–425.
141. Jonas JB, Nangia V, Matin A, et al. Prevalence, awareness, control, and associations of arterial hypertension in a rural Central India population: The Chennai India Eye and Medical Study. *Am J Hypertens.* 2010;23:347–350.
142. Kinra S, Bowen LJ, Lyngdoh T, et al. Sociodemographic patterning of noncommunicable disease risk factors in rural India: a cross sectional study. *BMJ.* 2010;341:c4974.
143. Kar SS, Thakur JS, Virdi NK, et al. Risk factors for cardiovascular diseases: is the social gradient reversing in northern India? *Natl Med J India.* 2010;23:206–209.
144. Chataut J, Adhikari RK, Sinha NP. The prevalence of and risk factors for hypertension in adults living in central development region of Nepal. *Kathmandu Univ Med J.* 2011;33:13–18.
145. Norboo T, Stobdan T, Tsering N, et al. Prevalence of hypertension at high altitude: cross-sectional survey in Ladakh, Northern India 2007–2011. *BMJ Open.* 2015;5:e007026.
146. Manimunda SP, Sugunan AP, Benegal V, et al. Association of hypertension with risk factors & hypertension related behaviour among the aboriginal Nicobarese tribe living in Car Nicobar Island, India. *Indian J Med Res.* 2011;133:287–293.
147. Thrift AG, Evans RG, Kalyanram K, et al. Gender-specific effects of caste and salt on hypertension in poverty: a population-based study. *J Hypertens.* 2011;29:443–450.
148. Bansal SK, Saxena V, Kandpal SD, et al. The prevalence of hypertension and hypertension risk factors in a rural Indian community: a prospective door-to-door study. *J Cardiovasc Dis Res.* 2012;3:117–123.
149. Bharati DR, Nandi P, Yamuna TV, et al. Prevalence and covariates of undiagnosed hypertension in the adult population of Puducherry, South India. *Nepal J Epidemiol.* 2012;2:191–199.
150. Dutta A, Ray MR. Prevalence of hypertension and pre-hypertension in rural women: a report from the villages of West Bengal, a state in the eastern part of India. *Aust J Rural Health.* 2012;20:219–225.
151. Esam MS, Husain AS. Prevalence of prehypertension and hypertension in rural Bareilly. *Nat J Med Res.* 2012;2:291–294.
152. Prasad DS, Kabir Z, Dash AK, et al. Prevalence and predictors of adult hypertension in an urban eastern Indian population. *Heart Asia.* 2012:49–52.
153. Vaidya A, Pathak RP, Pandey MR. Prevalence of hypertension in Nepalese community triples in 25 years: a repeat cross-sectional study in rural Kathmandu. *Indian Heart J.* 2012;6402:128–131.
154. Vaidya A. Is ethnicity an important determinant of high blood pressure in Nepalese population? A community-based cross-sectional study in Dawakot, Nepal. *Kathmandu Univ Med J.* 2012;10:20–231.
155. Meshram II, Arlappa N, Balkrishna N, et al. Prevalence of hypertension, its correlates and awareness among adult tribal population of Kerala state, India. *J Postgrad Med.* 2012;58:255–261.
156. Samuel P, Antonisamy B, Raghupathy P, et al. Socioeconomic status and cardiovascular risk factors in rural and urban areas of

Vellore, Tamil Nadu, South India. *Int J Epidemiol.* 2012;41:1315–1327.

157. Kaur M. Blood pressure trends and hypertension among rural and urban Jat women of Haryana, India. *Coll Antropol.* 2012;36:139–144.
158. Jeemon P, Prabhakaran D, Goenka S, et al. Sentinel Surveillance in Industrial Populations Study Group. Impact of comprehensive cardiovascular risk reduction programme on risk factor clustering associated with elevated blood pressure in an Indian industrial population. *Indian J Med Res.* 2012;135:485–493.
159. Gupta R, Sharma KK, Gupta A, et al. Persistent high prevalence of cardiovascular risk factors in the urban middle class in India: Jaipur Heart Watch-5. *J Assoc Phys India.* 2012;60:11–16.
160. Gupta R, Pandey RM, Misra A, et al. High prevalence and low awareness, treatment and control of hypertension in Asian Indian women. *J Hum Hypertens.* 2012;26:585–593.
161. Chinnakali P, Mohan B, Upadhyay RP, et al. Hypertension in the elderly: prevalence and health seeking behaviour. *N Am J Med Sci.* 2012;4:558–562.
162. Kokiwar PR, Gupta SS, Durge PM, et al. Prevalence of hypertension in a rural community of central India. *J Assoc Phys India.* 2012;60:26–29.
163. Borah PK, Shankarishan P, Hazarika NC, et al. Hypertension subtypes and angiotensin converting enzyme (ACE) gene polymorphism in Indian population. *J Assoc Phys India.* 2012;60:11.
164. Bhagyalaxmi A, Atul T, Shikha J. Prevalence of risk factors of non-communicable diseases in a district of Gujarat, India. *J Health Popul Nutr.* 2013;31:78–85.
165. Gupta R, Deedwania PC, Achari V, et al. Normotension, prehypertension, and hypertension in urban middle-class subjects in India: Prevalence, awareness, treatment, and control. *Am J Hypertens.* 2013;26:83–94.
166. Khan RJ, Stewart CP, Christian P, et al. A cross-sectional study of the prevalence and risk factors for hypertension in rural Nepali women. *BMC Public Health.* 2013;13:1–1055.
167. Adhikari K, Gupta N, Koshy AK. Gender differences on risk factors of non-communicable diseases—A community based cross-sectional study in Central Nepal. *JNHRC.* 2014;12:88–93.
168. Zaman MM, Bhuiyan MR, Karim MN, et al. Clustering of non-communicable diseases risk factors in Bangladeshi adults: an analysis of STEPS survey 2013. *Public Health.* 2015;15:659.
169. Gupta R, Sharma KK, Gupta BK, et al. Geographic epidemiology of cardiometabolic risk factors in middle class urban residents in India: cross-sectional study. *J Global Health.* 2015;5:010411.
170. Menon J, Vijaykumar N, Joseph JK, et al. Below the poverty line and non-communicable diseases in Kerala: The Epidemiology of Non-communicable Diseases in Rural Areas (ENDIRA) study. *Int J Cardiol.* 2015;187:519–524.
171. Ranasinghe P, Cooray DN, Jayawardena R, et al. The influence of family history of hypertension on disease prevalence and associated metabolic risk factors among Sri Lankan adults. *BMC Public Health.* 2015;15:576.
172. Rahman MM, Gilmour S, Akter S, et al. Prevalence and control of hypertension in Bangladesh: a multilevel analysis of a nationwide population-based survey. *J Hypertens.* 2015;33:465–472.
173. Bhansali A, Dhandania VK, Deepa M, et al. Prevalence of and risk factors for hypertension in urban and rural India: the ICMR-INDIAB study. *J Hum Hypertens.* 2015;29:204–209.
174. Edwards R, Unwin N, Mugusi F, et al. Hypertension prevalence and care in an urban and rural area of Tanzania. *J Hypertens.* 2000;18:145–152.
175. Amoah AG. Hypertension in Ghana: a cross-sectional community prevalence study in greater Accra. *Ethn Dis.* 2003;13:310–315.
176. Cappuccio FP, Micah FB, Emmett L, et al. Prevalence, detection, management, and control of hypertension in Ashanti, West Africa. *Hypertension.* 2004;43:1017–1022.
177. Erhun WO, Olayiwola G, Agbani EO, et al. Prevalence of hypertension in a university community in South West Nigeria. *Afr J Biomed Res.* 2005;8:15–19.
178. Agyemang C, Bruijnzeels MA, Owusu-Dabo E. Factors associated with hypertension awareness, treatment, and control in Ghana, West Africa. *J Hum Hypertens.* 2006;20:67–71.
179. 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;20:91–92.
180. Duda RB, Kim MP, Darko R, et al. Results of the Women's Health Study of Accra: assessment of blood pressure in urban women. *Int J Cardiol.* 2007;117:115–122.
181. Kengme AP, Awah PK, Fezeu L, et al. The burden of high blood pressure and related risk factors in urban Sub-Saharan Africa: evidences from Douala in Cameroon. *Afri Health Sci.* 2007;7:38–44.
182. Niakara A, Fournet F, Gary J, et al. Hypertension, urbanization, social and spatial disparities: a cross-sectional population-based survey in a West African urban environment (Ouagadougou, Burkina Faso). *Trans Roy Soc Trop Med Hyg.* 2007;101:1136–1142.
183. Omuemu VO, Okojie OH, Omuemu CE. Awareness of high blood pressure status, treatment and control in a rural community in Edo state. *Nig J Clin Prac.* 2007;10:208–212.
184. Thorogood M, Connor M, Tollman S, et al. A cross-sectional study of vascular risk factors in a rural South African population: data from the Southern African Stroke Prevention Initiative (SASPI). *BMC Public Health.* 2007;7:1–10326.
185. 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.
186. Grimsrud A, Stein DJ, Seedat S, et al. The association between hypertension and depression and anxiety disorders: results from a Nationally-representative sample of South African adults. *PLoS ONE.* 2009;4:1–9.
187. Tesfaye F, Byass P, Wall S. Population based prevalence of high blood pressure among adults in Addis Ababa: uncovering a silent epidemic. *BMC Cardiovasc Disord.* 2009;9:1–1039.
188. Wamala JF, Karyabakabo Z, Ndungutse D, et al. Prevalence of factors associated with hypertension in Rukungiri District, Uganda—A community-based study. *Afri Health Sci.* 2009;9:153–160.
189. Ekwunife OI, Udeogaranya PO, Nwatu IL. Prevalence, awareness, treatment and control of hypertension in a Nigerian population. *Health.* 2010;2:731–735.
190. Oladapo OO, Salako L, Sodiq O, et al. A prevalence of cardiometabolic risk factors among a rural Yoruba south-western Nigerian population: a population-based survey. *CVJ Africa.* 2010;21:26–31.
191. Sani MU, Wahab KW, Yusuf BO, et al. Modifiable cardiovascular risk factors among apparently healthy adult Nigerian population- a cross sectional study. *BMC Res Notes.* 2010;3:1–711.
192. 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;10:1–671.

193. Maher D, Waswa L, Baisley K, et al. Epidemiology of hypertension in low-income countries: a cross-sectional population-based survey in rural Uganda. *J Hypertens.* 2011;29:1061–1068.

194. Ulasi II, Ijoma CK, Onwubere BJ, et al. High prevalence and low awareness of hypertension in a market population in Enugu, Nigeria. *Intl J Hypertens.* 2011. doi: 104061/2011/869675.

195. Wokoma FS, Alasia DD. Blood pressure pattern in Barako—a rural community in Rivers state, Nigeria. *Nig Health J.* 2011;11:8–13.

196. Awoke A, Awoke T, Alemu S, et al. Prevalence and associated factors of hypertension among adults in Gondar, Northwest Ethiopia: a community based cross-sectional study. *BMC Cardiovasc Disord.* 2012;12:1–6113.

197. Dzudie A, Kengne AP, Muna WF, et al. Prevalence, awareness, treatment and control of hypertension in a self-selected Sub-Saharan African urban population: a cross-sectional study. *BMJ Open.* 2012;2:1–10.

198. Hendriks ME, Wit FW, Roos MT, et al. Hypertension in Sub-Saharan Africa: cross-sectional surveys in four rural and urban communities. *PLoS ONE.* 2012;7:1–10.

199. Macia E, Duboz P, Gueye L. Prevalence, awareness, treatment and control of hypertension among adults 50 years and older in Dakar, Senegal. *CVJ Africa.* 2012;23:265–269.

200. Mayega RW, Makumbi F, Rutebemberwa E, et al. Modifiable socio-behavioural factors associated with overweight and hypertension among persons aged 35 to 60 years in Eastern Uganda. *PLoS ONE.* 2012;7:1–9.

201. Msyamboza KP, Kathyola D, Dzowela T, et al. The burden of hypertension and its risk factors in Malawi: nationwide population-based STEPS survey. *Int Health.* 2012;4:246–252.

202. Adebayo RA, Balogun MO, Adedoyin RA, et al. Prevalence of hypertension in three rural communities of Ife North Local Government Area of Osun state, South West Nigeria. *Int J Gen Med.* 2013;6:863–868.

203. Asekun-Olarinmoye EO, Akinwusi PO, Adebimpe WO, et al. Prevalence of hypertension in the rural adult population of Osun state, southwestern Nigeria. *Int J Gen Med.* 2013;6:317–322.

204. Ekanem US, Opara DC, Akaowo CD. High blood pressure in a semi-urban community in south–south Nigeria: a community-based study. *Afr Health Sci.* 2013;13:56–61.

205. Kandala N-B, Tigbe W, Manda SO, et al. Geographic variation of hypertension in Sub-Saharan Africa: a case study of South Africa. *Am J Hypertens.* 2013;26:382–391.

206. Musinguzi G, Nuwaha F. Prevalence, awareness and control of hypertension in Uganda. *PLoS ONE.* 2013;8:1–7.

207. Ogah OS, Madukwe OO, Chukwuonye II, et al. Prevalence and determinants of hypertension in Abia state Nigeria: results from the Abia state non-communicable diseases and cardiovascular risk factors survey. *Etnicity Dis.* 2013;23:161.

208. Ogunmola OJ, Olaifa AO, Oladapo OO, et al. Prevalence of cardiovascular risk factors among adults without obvious cardiovascular disease in a rural community in Ekiti State, Southwest Nigeria. *BMC Cardiovasc Disord.* 2013;13:1–889.

209. Okpechi IG, Chukwuonye II, Tiffin N, et al. Blood pressure gradients and cardiovascular risk factors in urban and rural populations in Abia state south eastern Nigeria using the WHO STEPwise Approach. *PLoS ONE.* 2013;8:1–8.

210. Peer N, Steyn K, Lombard C, et al. A high burden of hypertension in the urban black population of Cape Town: the Cardiovascular Risk in Black South Africans (CRISBA) Study. *PLoS ONE.* 2013;8:1–8.

211. Peltzer K, Phaswana-Mafuya N. Hypertension and associated factors in older adults in South Africa. *CVJ Africa.* 2013;24:66–71.

212. Pessinaba S, Mbaye A, Yabeta GA, et al. Prevalence and determinants of hypertension and associated cardiovascular risk factors: data from a population-based, cross-sectional survey in Saint Louis, Senegal. *CVJ Africa.* 2013;24:180–183.

213. Awosan KJ, Ibrahim MTO, Essien E, et al. Dietary pattern, lifestyle, nutrition status and prevalence of hypertension among traders in Sokoto Central market, Sokoto, Nigeria. *Int J Nutr Metab.* 2014;6:9–17.

214. Awuah RB, Anarfi JK, Agyemang C, et al. Prevalence, awareness, treatment and control of hypertension in urban poor communities in Accra, Ghana. *J Hypertens.* 2014;32:1–8.

215. Doulougou B, Kouanda S, Bado A, et al. Hypertension in the adult population of Kaya health and demographic surveillance system in Burkina Faso: prevalence and associated factors. *Int J Trop Dis Health.* 2014;4:94–110.

216. Doulougou B, Kouanda S, Rossier C, et al. Differences in hypertension between informal and formal areas of Ouagadougou, a sub-Saharan African city. *BMC Public Health.* 2014;14:1–9893.

217. Duboz P, Boetsch G, Gueye L, et al. Hypertension prevalence, awareness, treatment and control in Dakar (Senegal). *J Hum Hypertens.* 2014;28:489–493.

218. Helelo TP, Gelaw YA, Adane AA. Prevalence and associated factors of hypertension among adults in Durame town, Southern Ethiopia. *PLoS ONE.* 2014;9:1–9.

219. Moges B, Amare B, Fantahun B, et al. High prevalence of overweight, obesity, and hypertension with increased risk to cardiovascular disorders among adults in northwest Ethiopia: a cross sectional study. *BMC Cardiovasc Disord.* 2014;14:1–10155.

220. Minicuci N, Biritwum RB, Mensah G, et al. Sociodemographic and socioeconomic patterns of chronic non-communicable disease among the older adult population in Ghana. *Glob Health Action.* 2014;7:21292.

221. Oladimeji AM, Fawole O, Nguku P, et al. Prevalence and factors associated with hypertension and obesity among civil servants in Kaduna, Kaduna State, June 2012. *Pan Afr Med J.* 2014;18 (Supp 1):13.

222. Oluyombo R, Olamoyegun MA, Olaifa O, et al. Cardiovascular risk factors in semi-urban communities in southwest Nigeria: patterns and prevalence. *J Epidemiol Global Health.* 2014;5:167–174.

223. Abebe SM, Berhane Y, Worku A, et al. Prevalence and associated factors of hypertension: a cross-sectional community based study in Northwest Ethiopia. *PLoS ONE.* 2015;10:e0125210.

224. Akpan EE, Ekrikpo UE, Udo AI, et al. Prevalence of hypertension in Akwa Ibom State, South–South Nigeria: rural versus urban communities study. *Int J Hypertens.* 2015. article ID 975819.

225. Angaw K, Dadi AF, Alene KA. Prevalence of hypertension among federal ministry civil servants in Addis Ababa, Ethiopia: call for a workplace-screening program. *BMC Cardiovasc Dis.* 2015;15:76.

226. Anteneh ZA, Yalew WA, Abitew DB. Prevalence and correlation of hypertension among adult population in Bahir Dar city, northwest Ethiopia: a community based cross-sectional study. *Int J Gen Med.* 2015;8:175–185.

227. Asiki G, Murphy GA, Baisley K, et al. Prevalence of dyslipidaemia and associated risk factors in a rural population in South-Western Uganda: a community based survey. *PLoS ONE.* 2015;10:e0126166.

228. Isara AR, Okundia PO. The burden of hypertension and diabetes mellitus in rural communities in southern Nigeria. *Pan Afr Med J.* 2015;20:103.

229. Musinguzi G, Geertruyden J-P, Bastiaens H, et al. Uncontrolled hypertension in Uganda: a comparative cross-sectional study. *J Clin Hypertens.* 2015;17:63–70.

230. Oguoma VM, Nwose EU, Skinner TC, et al. Prevalence of cardiovascular disease risk factors among a Nigerian adult population: relationship with income level and accessibility to CVD risks screening. *BMC Public Health.* 2015;15:397.
231. Wandera SO, Kwagala B, Ntozi J. Prevalence and risk factors for self-reported non-communicable diseases among older Ugandans: a cross-sectional study. *Glob Health Action.* 2015;8:27923.
232. Sowemimo I, Ajayi I, Akpa O, et al. Prevalence of hypertension and associated factors among residents of Ibadan-north local government area of Oyo state, Nigeria. *J Hypertens.* 2015;33(Supp 1):e31.
233. Kingue S, Ngoe CN, Menanga AP, et al. Prevalence and risk factors of hypertension in urban areas of Cameroon: a nationwide population-based cross-sectional study. *J Clin Hypertens (Greenwich).* 2015;3: doi: 101111/jch12604.
234. Bushara SO, Noor SK, Elmadhoun WM, et al. Undiagnosed hypertension in a rural community in Sudan and association with some features of the metabolic syndrome: how serious is the situation? *Ren Fail.* 2015;4:1–5.
235. Seck SM, Diop-Dia A, Dia DG, et al. Prevalence of hypertension and assessment of its impact on self-rated health in rural populations: a cross-sectional study in northern Senegal. *Med Sante Trop.* 2015;3: [Epub ahead of print].
236. Ezeala-Adikaibe BA, Orjioke C, Ekenze OS, et al. Population-based prevalence of high blood pressure among adults in an urban slum in Enugu, South East Nigeria. *J Hum Hypertens.* 2015;28: Doi: 101038/jhh201549.
237. Ibekwe R. Modifiable risk factors of hypertension and sociodemographic profile in Oghara, Delta State; prevalence and correlates. *Ann Med Health Sci Res.* 2015;5:71–77.
238. Ugwuja E, Ezenkwa U, Nwibo A, et al. Prevalence and determinants of hypertension in an agrarian rural community in southeast Nigeria. *Ann Med Health Sci Res.* 2015;5:45–49.
239. Botha S, Fourie CM, Schutte R, et al. Soluble urokinase plasminogen activator receptor and hypertension among black South Africans after 5 years. *Hypertens Res.* 2015;38:439–444.
240. Sander LD, Newell K, Ssebbowa P, et al. Hypertension, cardiovascular risk factors and antihypertensive medication utilisation among HIV-infected individuals in Rakai, Uganda. *Trop Med Int Health.* 2015;20:391–396.
241. Amuna P, Zotor FB. Epidemiological and nutrition transition in developing countries: impact on human health and development. *Proc Nutr Soc.* 2008;67:82–90.
242. Kroll M, Bharucha E, Kraas F. Does rapid urbanization aggravate health disparities? Reflections on the epidemiological transition in Pune, India. *Glob Health Action.* 2014;7:23447.
243. Pereira M, Lunet N, Azevedo A, et al. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens.* 2009;27:963–975.
244. Jousilahti P, Vartiainen E, Tuomilehto J, et al. Sex, age, cardiovascular risk factors, and coronary heart disease. A prospective follow-up study of 14786 middle-age men and women in Finland. *Circulation.* 1999;99:1165–1172.
245. Rosano GM, Vitale C, Marazzi G, et al. Menopause and cardiovascular disease: the evidence. *Climacteric.* 2007;1:19–24.
246. Pinto E. Blood pressure and ageing. *Postgrad Med J.* 2007;83:109–114.
247. Franklin SS, Gustin W, Wong ND, et al. Hemodynamic patterns of age-related changes in blood pressure. The Framingham Heart Study. *Circulation.* 1997;96:308–315.
248. Landahl S, Bengtsson C, Sigurdsson JA, et al. Age-related changes in blood pressure. *Hypertension.* 1986;8:1044–1049.
249. Singh RB, Suh IL, Singh VP. Hypertension and stroke in Asia: prevalence, control and strategies in developing countries for prevention. *J Hum Hypertens.* 2000;14:749–763.
250. Thawornchaisit P, de Looze F, Reid CM, et al. Health risk factors and the incidence of hypertension: 4-year prospective findings from a national cohort of 60 569 Thai Open University students. *BMJ Open.* 2013;3:e002826.
251. Hammer GP, du Prel J, Blettner M. Avoiding bias in observational studies. *Dtsch Arztebl Int.* 2009;106:664–668.
252. Dyer AR, Elliot P, Shipley M. Body mass index versus height and weight in relation to blood pressure. *Am J Epidemiol.* 1990;131:589–596.
253. Folsom AR, Kushi LH, Anderson KE, et al. Associations of general and abdominal obesity with multiple health outcomes in older women: the Iowa Women's Health Study. *Arch Intern Med.* 2000;160:2117–2128.
254. Hu G, Barengo NC, Tuomilehto J, et al. Relationship of physical activity and body mass index to the risk of hypertension: a prospective study in Finland. *Hypertension.* 2004;43:25–30.
255. Radi S, Lang T, Lauwers-Cances V, et al. One-year hypertension incidence and its predictors in a working population: the IHPAF study. *J Hum Hypertens.* 2004;18:487–494.
256. Ioannidis JP, Patsopoulos NA, Rothstein HR. Reasons or excuses for avoiding meta-analysis in forest plots. *BMJ.* 2008;336:1413–1415.
257. Higgins JP. Commentary: heterogeneity in meta-analysis should be expected and appropriately quantified. *Int J Epidemiol.* 2008;37:1158–1160.
258. Terrin N, Schmid CH, Lau J, et al. Adjusting for publication bias in the presence of heterogeneity. *Stat Med.* 2003;22:2113–2126.
259. Huang Z, Willett WC, Manson JE, et al. Body weight, weight change, and risk for hypertension in women. *Ann Intern Med.* 1998;128:81–88.
260. Kaufman JS, Owoaje EE, James SA, et al. Determinants of hypertension in West Africa: contribution of anthropometric and dietary factors to urban–rural and socioeconomic gradients. *Am J Epidemiol.* 1996;143:1203–1218.
261. Rose G, Stamler J, Stamler R, et al. Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. *BMJ.* 1998;297:319–328.
262. Stamler J. The INTERSALT Study: background, methods, findings, and implications. *Am J Clin Nutr.* 1997;65:626S–642S.
263. Zhao L, Stamler J, Yan LL, et al. Blood pressure differences between northern and southern Chinese: role of dietary factors: the International Study on Macronutrients and Blood Pressure. *Hypertension.* 2004;43:1332–1337.
264. Fateh M, Emamian MH, Asgari F, et al. Socioeconomic inequality in hypertension in Iran. *J Hypertens.* 2014;32:1782–1788.
265. He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: cochrane systematic review and meta-analysis of randomised trials. *BMJ.* 2013;346:3.
266. World Health Organization. 2015. Creating an enabling environment for population-based salt reduction strategies. [online] Available at: http://www.who.int/dietphysicalactivity/reducingsalt/en/ .(Accessed 17/05/2015).
267. World Health Organization. 2012. Guideline: Potassium intake for adults and children. [online] Available at: http://apps.who.int/iris/bitstream/10665/77986/1/9789241504829_eng.pdf?ua=1 (Accessed 15/05/2015).
268. Stranges S, Cappuccio FP. Prevention and management of hypertension without drugs. *Curr Hypertens Rev.* 2007;3:182–195.
269. Murray CJL, Lauer JA, Hutubessy RCW, et al. Effectiveness and costs of interventions to lower systolic blood pressure and cholesterol: a global and regional analysis on reduction of cardiovascular-disease risk. *Lancet.* 2003;361:717–725.