

An estimate of the prevalence of hypertension in Nigeria: a systematic review and meta-analysis

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Background: Hypertension is a leading cause of morbidity and mortality in Africa, and Nigeria, the most populous country in the continent, hugely contributes to this burden.

Objective: To provide an improved estimate of the prevalence and number of cases of hypertension in Nigeria based on the cut-off 'at least 140/90 mmHg', towards ensuring better awareness, control and policy response in the country.

Methods: We conducted a systematic search of Medline, EMBASE and Global Health from January 1980 to December 2013 for population-based studies providing estimates on the prevalence of hypertension in Nigeria. From the extracted crude prevalence rates, we conducted a random-effects meta-analysis, and further estimated the overall awareness rate of hypertension in Nigeria, expressed as percentage of all hypertension cases. We applied a meta-regression epidemiological modelling, using United Nations population demographics for the years 2010 and 2030, to determine the prevalence and number of cases of hypertension in Nigeria for the 2 years.

Results: Our search returned 2260 publications, 27 of which met our selection criteria. From the random-effects meta-analysis, we estimated an overall hypertension prevalence of 28.9% (25.1, 32.8), with a prevalence of 29.5% (24.8, 34.3) among men and 25.0% (20.2, 29.7) among women. We estimated a prevalence of 30.6% (24.5, 36.6) and 26.4% (19.4, 33.4) among urban and rural dwellers, respectively. The pooled awareness rate of hypertension was 17.4% (11.4, 23.3). The overall mean SBP was 128.6 (125.5, 130.8) mmHg, and the DBP was 80.6 (78.5, 82.7) mmHg. From our modelling, we estimated about 20.8 million cases of hypertension in Nigeria among people aged at least 20 years in 2010, with a prevalence of 28.0% (24.6, 31.9) in both sexes – 30.7% (24.9, 33.7) among men and 25.2% (22.7, 31.9) among women. By 2030, we projected an increase to 39.1 million cases of hypertension among people aged at least 20 years with a prevalence of 30.8% (24.5, 33.7) in both sexes – 32.6% (27.3, 38.2) among men and 29.0% (21.9–32.2) among women.

Conclusions: Our findings suggest the prevalence of hypertension is high in Nigeria, and the overall awareness of raised blood pressure among hypertension cases is low

in the country. We hope this study will inform appropriate public health response towards reducing this burden.

Keywords: Africa, burden, cardiovascular disease, hypertension, Nigeria, prevalence

Abbreviations: DALYs, Disability-Adjusted Life Years; ICSSHIB, International Collaborative Study of Hypertension in Black; ISH, International Society of Hypertension; JNC, Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure; LMIC, low and middle-income countries; MESH, Medical Subject Headings; NCDs, non-communicable diseases; UN, United Nations; USD, United States dollars

INTRODUCTION

The burden of non-communicable diseases (NCDs), including hypertension, is fast rising globally, and reports from the 2013 World Health Day global brief on hypertension shows that Africa, in particular, is worst hit [1]. WHO, public health experts and stakeholders have declared NCDs a global priority, as documented in the 2011 United Nations (UN) high-level meeting, with a target towards reducing this growing burden in Africa and other low and middle-income countries (LMICs) [2], where an existing burden from many infectious diseases has contributed to a double burden of disease [3].

Hypertension is estimated to affect about one billion people worldwide and is a major risk factor for many cardiovascular diseases [1]. Cardiovascular diseases are responsible for about 17 million deaths globally, with

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complications from high blood pressure resulting in about 7.5 million deaths and 57 million disability-adjusted life years (DALYs) worldwide, both accounting for about 12.8 and 3.7% of global deaths and DALYs, respectively [1,4]. Nigeria, currently with a population of over 160 million, is the most populous African country [5], and the prevalence of hypertension in the country hugely contributes to the overall burden in Africa [6]. In 2008, the WHO estimated hypertension prevalence of 42.8% in Nigeria [7]. This is believed to be due to an increasing adult population, rapid urbanization and uptake of western lifestyles, including high consumption of processed foods (with high salts and fats), tobacco and alcohol products [8,9].

The 1997 Nigerian national NCDs survey committee reported a hypertension prevalence of 11.2% in both sexes, which was then about 4.33 million hypertension cases in people aged above 15 years [10]. This survey could have underestimated the prevalence of hypertension in Nigeria, as the diagnosis was based on the old definition of hypertension ($\geq 160/95$ mmHg) [8,11]. From the 2003 national NCDs survey conducted mainly in the south-west region, which was based on SBP at least 140 mmHg and/or DBP at least 90 mmHg, the overall prevalence of hypertension was 28.9% [12]. In addition, recent surveys in various parts of Nigeria based on at least 140/90 mmHg have also shown a higher prevalence of hypertension, ranging from 25.0 to 36.6% [9].

One major problem affecting the response to this burden in Nigeria is that the awareness, treatment and control of hypertension have been low [13]. Consequently, many who live with high blood pressures end up in health facilities with cardiovascular complications, including heart failures, ischemic heart disease and strokes [14]. In fact, research findings show that high blood pressure is diagnosed in many people as an incidental finding when admitted for unrelated ailments [15]. This obviously has resulted in high morbidities and mortalities from hypertension in Nigeria [3], and reports still show that there is yet to be a nationwide measure to facilitate regular screening and detection of high blood pressures [8,16,17]. The WHO reiterated the need for improved awareness on high blood pressure towards reducing the overall burden of the disease, especially at national and community levels, as this was the focus of the 2013 WHO day [1]. Additionally, there is also a high economic burden as a consequence of hypertension and associated cardiovascular complications in Nigeria [18], demonstrated by direct costs, for example: the cost of antihypertensive medications, administrative fees, laboratory fees and other out-of-pocket health expenditures, and indirect costs, such as: loss of savings from repeated healthcare expenses, hospital waiting times and work absenteeism [19]. In a study of 250 patients in Igbo-Ora, southwest Nigeria, for instance, the mean monthly cost of treatment was reported to be about 10 United States Dollars (USD) and this is relatively high in a community in which majority of the population live on an income below 2 USD per day [20]. Furthermore, some reports have shown that the actual mean monthly cost could be more than this, as the study did not consider re-treatment visits which could be up to five visits per patient within 6 months [19].

The burden of hypertension in Nigeria is high and still growing [8], and we still cannot say with certainty the exact rates. In the past 20 years, there has been an increase in hypertension research in Nigeria, as several community-based prevalence studies have been conducted [21]. There is therefore a need for current estimates of the prevalence of hypertension in the country to effectively quantify this burden and prompt appropriate response as previous countrywide estimates have been based on a review of fewer studies, mostly based on at least 160/95 mmHg [21]. The aim of this study was to provide an improved estimate of hypertension in Nigeria, based on the current definition (cut-off ' $\geq 140/90$ mmHg') [22–25], towards ensuring improved awareness, control and treatment, and a better policy response.

METHODS

Search strategy and selection criteria

After identification of the relevant Medical Subject Headings (MESH) and keywords, a final search strategy was developed. Searches were conducted in three main databases: Medline, EMBASE and Global Health. The search date was set from January 1980 to September 2013, as studies conducted after 1980 broadly reflect the introduction of hypertension definition based on at least 140/90 mmHg, which is our broad diagnostic criteria (see 'Case definitions' section below). See Table 1 for details of the search terms.

We included cross-sectional population and/or community-based studies on hypertension published in or after 1980, conducted among people aged at least 15 years, and providing numerical estimates on the prevalence or awareness rates of hypertension in Nigeria. We excluded studies conducted before 1980, hospital-based, without numerical estimates, on non-human participants, and that were mainly reviews. We also ensured the retained studies had clearly defined study designs, diagnostic criteria and blood pressure measurement protocols.

TABLE 1. Search terms

#	Search terms
1	nigeria/ or 'africa south of the sahara'/
2	Nigeria .mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
3	1 or 2
4	exp vital statistics/ or exp incidence/
5	(incidence* or prevalence* or morbidity or mortality).tw.
6	(disease adj3 burden).tw.
7	exp 'cost of illness'/
8	exp quality-adjusted life years/
9	QALY.tw.
10	Disability adjusted life years.mp.
11	(initial adj2 burden).tw.
12	exp risk factors/
13	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
14	cardiovascular diseases/ or heart diseases/ or exp hypertension/ or peripheral vascular diseases/
15	Hypertensive heart disease.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
16	14 or 15
17	3 and 13 and 16
18	limit 17 to (humans and yr='1980 -Current')

Case definitions

We included studies with hypertension defined as: SBP at least 140 mmHg and/or DBP at least 90 mmHg. To satisfy this definition, included studies needed to comply with the hypertension diagnostic criteria based on the following: the sixth and seventh report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure (JNC6 and JNC7) [22,23], the 1999 WHO/International Society of Hypertension (WHO/ISH) definitions and classification of blood pressure levels [24], and the 2003 WHO/ISH Statement on Management of Hypertension [25]; as these criteria all have their hypertension cut-off based on 140/90 mmHg. However, many studies before 1999 were based on different blood pressure classifications (with hypertension mostly defined as $\geq 160/95$ mmHg). For these studies, we extracted any subgroup analysis based on our initial definition and calculated the hypertension prevalence only from this subgroup. Thus, all included studies were finally based on SBP (≥ 140 mmHg) and/or DBP (≥ 90 mmHg).

For the awareness rate of hypertension, we included studies estimating the prevalence of hypertension based on the above definition, with awareness rate of hypertension defined as self-report by respondents of any prior diagnosis of hypertension by a doctor or a certified health worker, and excluding women diagnosed during pregnancy [25].

Data extraction and analysis

All extracted data were stored in the Microsoft Excel file format. The data were abstracted systematically on sample size, mean age or age range, number of hypertension cases, and their respective age and sex-specific prevalence rates. These were sorted into mixed, urban and rural settings (based on studies that reported them). An independent parallel search and double extraction was conducted by C.B. and A.V.A., respectively. For studies conducted on the same study site, population or cohort, the first chronologically published study was selected, and all additional data from other studies were compared for consistency and included in the selected study.

As noted above, awareness of hypertension was defined as the number of people who reported being aware of their hypertension status. From each study, the awareness rate of hypertension was estimated as the number of people who reported being hypertensive, expressed as a percentage of total number of people in the study population adjudged to have hypertension. Pooled awareness rate of hypertension (relative to the sample size of the study population) was then estimated using a random-effects meta-analysis (DerSimonian and Laird method) [26].

We further conducted a random-effects meta-analysis on crude hypertension prevalence rates from all study sites, and separately pooled estimates for urban and rural settings. We further conducted a meta-regression-like analysis on all data points, employing an epidemiological model adjusted for mean ages, with the size of bubble corresponding to the reported sample sizes in each study, and the fitted curve explaining the largest proportion of variance (best fit) was applied. Data from studies conducted before 2010 were used to estimate the prevalence and cases of hypertension

in 2010. The equations generated from the fitted model were then separately used to estimate the number of cases of hypertension at midpoints of the UN population 5-year age groups for the year 2010 [27]. This epidemiological model has been described in two previous studies [28,29]. To give a close prediction of the prevalence of hypertension in Nigeria in 2030 with appropriate consideration of the expected population growth and ageing in the country, we modelled all data extracted from the remaining studies (representing the period 2010–2013) to arrive at these predicted estimates, as the UN population figures were also partly extrapolated from the projected population growth and ageing. All statistical analyses were conducted on Microsoft Excel (2010) and Stata 13.1 (Copyright 1985–2013 Stata Corp LP, College Station, Texas, USA).

RESULTS

Systematic review

Our search returned 2260 publications from Medline (551), EMBASE (710) and Global Health (999). A further four studies were included from other sources. 1908 studies remained after removing duplicates. On screening titles for relevance (i.e. hypertension studies conducted primarily on Nigerian populations), 1769 studies were excluded. We therefore assessed 139 full texts, and after applying the quality criteria, 112 studies were excluded [56 articles did not provide numerical estimates for prevalence and cases of hypertension, 47 articles did not specify study designs and blood pressure measurement protocols, and nine studies were based on a cut-off of $\geq 160/95$ mmHg (without any group estimate based on 140/90 mmHg)]. A total of 27 studies were finally retained for the review (see Fig. 1 for flow diagram of study selection).

Study characteristics

The 27 studies [30–56] were conducted across the six geopolitical zones of Nigeria (south-west 10, south-east 7, south-south 6, north-central 2, north-east 1, north-west 1), with most studies (88%) completed within 1 year (see Table 2). The overall sample size from all retained studies was 27 122, with a mean and median of 1005 and 756, respectively. Of the 27 studies, 21 reported hypertension prevalence estimates by sex. The total sample size of the male population was 10 759 (mean 512) and that of the female population was 10 297 (mean 490). Fourteen studies (51.9%) were conducted in predominantly urban settings, with a total sample size of 11 726 (mean 838). Studies from rural settings were seven, whereas studies conducted in mixed settings (which describe a study conducted across both urban and rural settings, with a single prevalence estimate reported for this setting) were six in all. Many studies applied the JNC7 and WHO/ISH 2003 hypertension classifications, both representing about 45% of all criteria used. The studies were mostly conducted on people aged at least 20 years, with an estimated overall mean age of 45.1 years, ranging from 30.7 to 71.1 years. For the age determination of patients across selected studies, birth certificates were mostly employed, and in the absence of valid age-verification documents, patients' age was determined from historical landmarks.

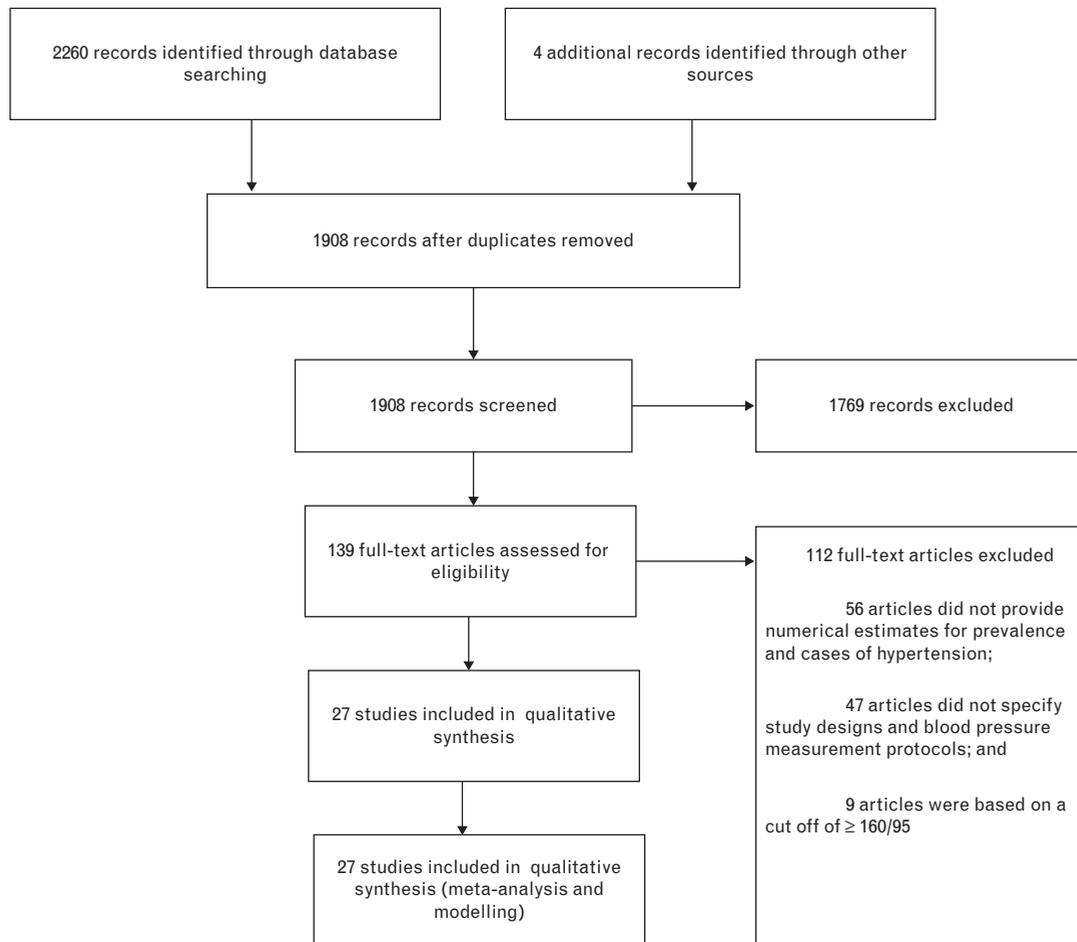


FIGURE 1 Flow chart of study selection.

Pooled estimates

On the basis of reported prevalence rates in individual studies, the highest prevalence of hypertension was

TABLE 2. Characteristic distribution of selected studies

	Number of studies
Study location (according to the 6 geopolitical zones of Nigeria)	
South-west [30,31,34–36,39,43,46,48,51]	10
South-east [37,40,42,47,49,55,56]	7
South-south [33,38,41,52–54]	6
North-central [44,50]	2
North-east [32]	1
North-west [45]	1
Duration of study	
<1 year	23
1–3 years	4
>3 years	0
Sample size	
<1000	17
1001–3000	10
>3000	0
Study setting	
Rural	6
Urban	14
Mixed ^a	7

^aMixed setting refers to a study conducted across both urban and rural settings, with a single prevalence estimate reported for this setting.

recorded in Ogbomoso (south-west Nigeria) and Abak (south-south Nigeria), both having a prevalence of 50.5% in 2008 (mean age 48.7 years) and 47% in 2012 (mean age 31.7 years), respectively [35,41]. Other sites reporting a high prevalence of hypertension were from Enugu (south-east Nigeria), with a prevalence of 44.5% in 2011 (mean age 57.3 years), 46.4% in 2006 (mean age 59.8 years) and 42.2% in 2010 (mean age 38.0 years) [37,40,56]. Across all study sites, lowest hypertension prevalence was reported in Ibadan (south-west Nigeria) with a prevalence of 9.3% in 2008 (mean age 38.3 years) [46] (see Table 3 for summary of data from all retained studies).

From the random-effects meta-analysis conducted on all data points, we estimated an overall hypertension prevalence of 28.9% [95% confidence interval (CI) 25.1–32.8, $I^2=98.2\%$, $P=0.000$], with men having 29.5% (95% CI 24.8–34.3, $I^2=96.8\%$, $P=0.000$) and women having 25.0% (95% CI 20.2–29.7, $I^2=97.2\%$, $P=0.000$). The pooled prevalence of hypertension in the urban settings was higher than that in the rural settings. We estimated prevalence rates of 30.6% (95% CI 24.5–36.6, $I^2=96.8\%$, $P=0.000$) among the urban dwellers, and 26.4% (95% CI 19.4–33.4, $I^2=96.8\%$, $P=0.000$) among the rural dwellers (Table 4 and Figs. 2–4).

From all studies reporting mean blood pressures, the overall pooled estimates (random-effect meta-analysis) of

TABLE 3. Summary of data from all studies

Author, year (location, setting)	Study period	Diagnostic criteria	Mean age in years (all)	Prevalence % (all)	Prevalence % (men)	Prevalence % (women)
Abegunde and Owoaje, 2013 (Oyo, South-west, mixed) [30]	2010–2011	JNC7	71.1	34.8	–	–
Adedoyin <i>et al.</i> , 2008 (Ile-Ife, south-west, semi-urban) [31]	2007–2008	JNC7	44.2	36.6	36.8	36.4
Adedoyin <i>et al.</i> , 2012 (Borno, north-east, semi-urban) [32]	2011–2012	JNC7, WHO/ISH 2003	41.5	25.2	24.7	24.7
Ahaneku <i>et al.</i> , 2011 (Enugu, south-east, rural) [37]	2010–2011	≥140/90	57.3	44.5	49.3	42.3
Alikor <i>et al.</i> , 2013 (Rivers, south-south, rural) [33]	2012–2013	JNC7	41.3	20.2	20.5	20.1
Amira <i>et al.</i> , 2012 (Lagos, south-west, urban) [34]	2006–2010	JNC7	41.9	33	38.3	27.8
Amole <i>et al.</i> , 2011 (Ogbomoso, south-west, semi-urban) [35]	2008	JNC7	48.7	50.5	52	49.3
Asekun-Olarinmoye <i>et al.</i> , 2013 (Osun, south-west, rural) [36]	2011	JNC7, WHO/ISH 2003	49.7	13.2	15	11.9
Bunker <i>et al.</i> , 1992 (Benin, south-south, urban) [38]	1987–1988	≥140/90	36.35	31.1	34	17
Cooper <i>et al.</i> , 1997 (Ibadan, south-west, mixed) [39]	1995	≥140/90	49.5	14.5	14.7	14.3
Ejim <i>et al.</i> , 2011 (Enugu, south-east, rural) [40]	2005–2006	≥140/90	59.8	46.4	50.2	44.8
Ekanem <i>et al.</i> , 2013 (Abak, south-south, semi-urban) [41]	2012	JNC7	31.7	47	30.1	16.8
Ekwunife <i>et al.</i> , 2010 (Nsukka, south-east, mixed) [42]	2009	≥140/90	34.9	21.1	–	–
Erhun <i>et al.</i> , 2004 (Ile-Ife, south-west, semi-urban) [43]	2002–2003	JNC6, WHO/ISH 1999	55	21	23.3	16.4
Hendriks <i>et al.</i> , 2012 (Kwara, north-central, rural)	2009–2011	≥140/90	45.3	21	–	–
Isezuo <i>et al.</i> , 2011 (Sokoto, north-west, mixed) [45]	2009–2010	JNC7	38.9	24.8	25.9	23.6
Kadiri <i>et al.</i> , 1999 (Ibadan, south-west, urban) [46]	1997–1998	≥140/90	38.3	9.3	10.4	7.1
Mbah <i>et al.</i> , 2013 (Nsukka, south-east, semi-urban) [47]	2011–2012	JNC7	50	32.5	–	–
Odugbemi <i>et al.</i> , 2012 (Lagos, south-west, urban) [48]	2009–2010	≥140/90	43.885	34.8	–	–
Ogah <i>et al.</i> , 2013 (Abia, south-east, mixed) [49]	2011–2012	JNC7	41.7	31.8	33.5	30.5
Oghagbon <i>et al.</i> , 2008 (Ilorin, north-central, urban) [50]	2006–2007	WHO/ISH 2003	50.5	27.1	28.4	22.9
Oladapo <i>et al.</i> , 2010 (Egbeda, south-west, rural) [51]	2002–2005	JNC7	42.1	20.8	21.1	20.5
Omorogiuwa <i>et al.</i> , 2009 (Ekpoma, south-south, urban) [52]	2007–2008	≥140/90	41.6	33	28.1	36.4
Omuemu <i>et al.</i> , 2007 (Edo, south-south, rural) [53]	2004–2005	WHO/ISH 2003	30.7	20.2	24.8	13.2
Suleiman <i>et al.</i> , 2013 (Amasomma, south-south, semi-urban) [54]	2011	JNC7	50.5	15	18.8	12.5
Ulasi <i>et al.</i> , 2010 (Enugu, south-east, Semi-urban) [55]	2007–2008	WHO/ISH 2003	40.8	32.8	–	–
Ulasi <i>et al.</i> , 2011, Enugu, south-east, mixed) [56]	2009–2010	WHO/ISH 2003	38.02	42.2	46.3	37.7

JNC, Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure [22,23], ISH, International Society of Hypertension [24,25].

SBP and DBP were 128.6 (125.5, 130.8) mmHg and 79.4 (78.5, 82.7) mmHg, respectively (Table 4 and Fig. 5).

On the basis of our definition of awareness of hypertension, only six studies satisfied this definition (percentage of people with hypertension who were aware of their hypertension status). The pooled hypertension awareness rate (random-effect meta-analysis) was 17.4% (11.4, 23.3) (Table 4 and Fig. 6).

Modelled estimates

Our modelling showed the overall cases and prevalence of hypertension were high in Nigeria. We estimated about 20.8 million cases of hypertension in Nigeria among people aged at least 20 years in 2010, with a prevalence of 28.0% (24.6, 31.9). Just as observed from the crude estimates

(meta-analysis), the prevalence of hypertension among men was higher than that among women. We estimated over 11.4 million cases of hypertension with a prevalence of 30.7% (24.9, 33.7) among men, and 9.3 million cases with a prevalence of 25.2% (22.7, 31.9) among women (Table 5 and Fig. 7 for details). We projected an increase to about 39.1 million cases of hypertension by 2030 in people aged at least 20 years, with a prevalence of 30.8% (24.5, 33.7). Among men, we projected an increase to over 20.7 million cases with a prevalence of 32.6% (27.3, 38.2), and an increase to about 18.3 million cases with a prevalence of 29.0% (21.9, 32.2) among women. These projections are mainly based on expected population growth and ageing of the Nigerian population by the year 2030 (Table 6 and Fig. 8 for details).

TABLE 4. Pooled hypertension prevalence rates from all studies

Setting	Mean age (years)	Prevalence and awareness rates of hypertension (%)				Mean blood pressure (mmHg)	
		Both sexes ^a (95% CI)	Men ^a (95% CI)	Women ^a (95% CI)	Awareness rate (95% CI)	SBP (95% CI)	DBP (95% CI)
Overall ^b	45.1	28.9 (25.1, 32.8)	29.5 (24.8, 34.3)	25.0 (20.2, 29.7)	17.4 (11.4, 23.3)	128.6 (125.5, 130.8)	80.6 (78.5, 82.7)
Mixed	45.7	28.1 (19.6, 36.7)	29.9 (17.2, 42.8)	26.4 (15.9, 36.9)	–	–	–
Urban	44.1	30.6 (24.5, 36.6)	29.4 (22.6, 36.2)	24.3 (16.7, 31.8)	–	–	–
Rural	46.9	26.4 (19.4, 33.4)	29.6 (19.9, 39.3)	25.3 (15.1, 35.5)	–	–	–

Mixed setting refers to a study conducted across both urban and rural settings, with a single prevalence estimate reported for this setting (see Table 4 for more details). CI, confidence interval.

^aHypertension prevalence.

^bEstimates are from all data points.

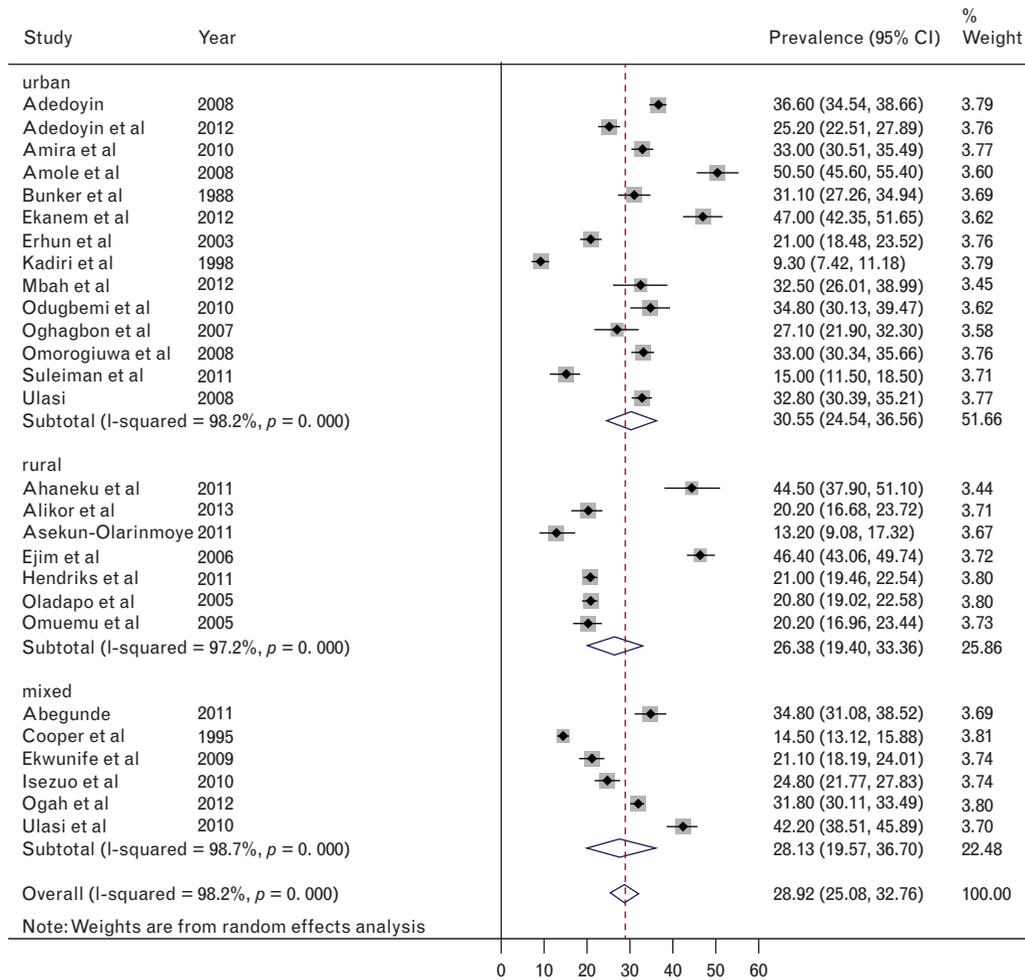


FIGURE 2 Forest plot of crude hypertension prevalence rates in both sexes in Nigeria.

DISCUSSION

There are clear indications of the need for an estimate of hypertension in Nigeria [21], as a countrywide hypertension prevalence was last estimated in Nigeria during the 1997 national survey of NCDs [10], and a follow-up done in 2003 was inconclusive and limited only to south-western Nigeria [12]. There has been a gradual increase of community-based studies from various sites within the country in the past two decades using the recent WHO/ISH and JNC7 definitions, and most reporting higher prevalence rates of hypertension [8,21]. We therefore believe a countrywide estimate of hypertension prevalence by systematically selecting the relevant studies (*vis-à-vis* standard diagnostic criteria and blood pressure-measuring protocols) may help address pertinent health challenges, prompt more research efforts and inform appropriate public health response. This review thus provides an improved countrywide estimate of the prevalence of hypertension in Nigeria for the years 2010 and 2030, using an epidemiological model adjusted for age and sample sizes of the study populations.

We estimated overall mean SBP and DBP of 128.6 and 80.6 mmHg in Nigeria. This, to the best of our knowledge, is the first countrywide estimate of SBP and DBP in Nigeria.

This estimate is relatively comparable with the estimates reported for sub-Saharan Africa between 1981 and 2008 by Danaei *et al.* [57], with an overall mean SBP ranging from 129.2 to 132.7 mmHg and 132.6 and 134.8 mmHg among men and women, respectively. This may broadly reflect an increasing overall mean blood pressure and a rising prevalence of hypertension in the country when compared to other world regions [58]. From the pooled crude prevalence rates, we observed that the prevalence of hypertension was higher among the urban dwellers than that observed among the rural dwellers (31 versus 26%). This is in line with several studies in Nigeria and other contextually comparable African countries where a higher prevalence of hypertension has been reported among the urban dwellers [59]. For example, in 2008, a prevalence of 22.3% was estimated among the urban dwellers in Nigeria as compared to a prevalence of 15.0% among the rural dwellers [60]. This may possibly reflect intense physical activities from long walking hours and rigorous farming in most rural places, coupled with better consumption of locally available fruits and vegetables, and a probable absence of western lifestyles [61,62].

One important finding from this study is the low rate of awareness on hypertension. We reported a pooled

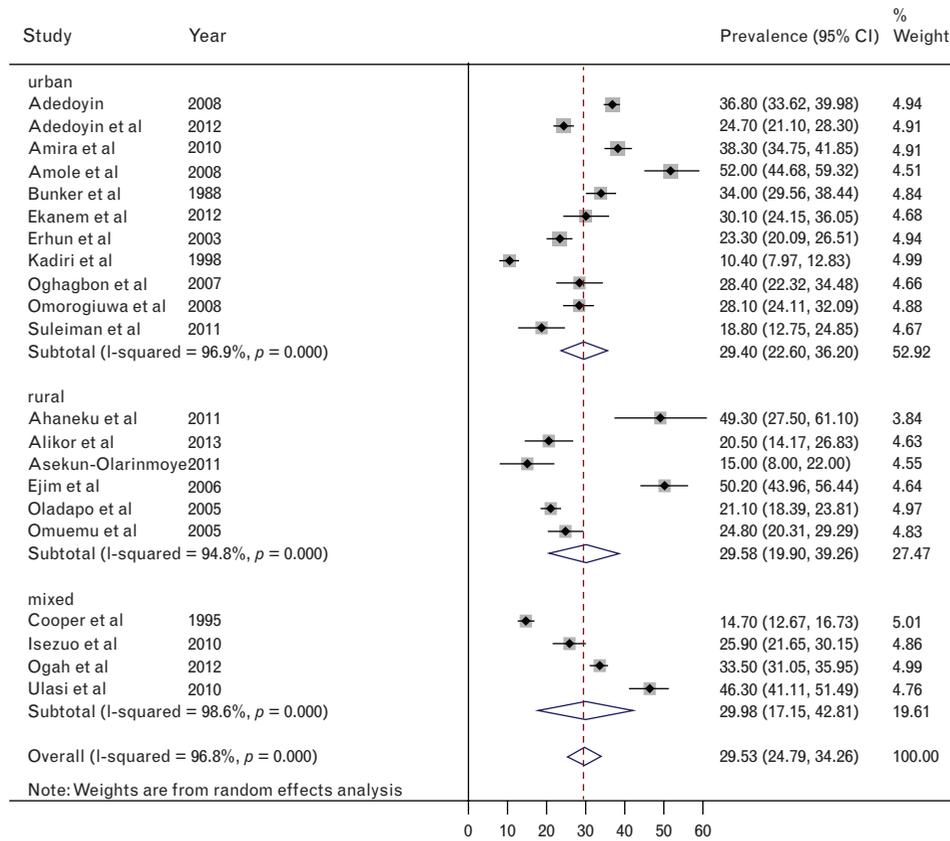


FIGURE 3 Forest plot of crude hypertension prevalence rates among men in Nigeria.

awareness rate (expressed as a percentage of cases of hypertension) of 17.4% (11.4, 23.3) in Nigeria. This also remains the first countrywide estimate of awareness rate of hypertension in Nigeria. This awareness rate is relatively in line with reports from many studies in other parts of Africa (Gabon 9%, Uganda 10% and Kenya 12.3%) [63–65]. This may be indicative of the high morbidities and mortalities from hypertension and associated complications in many African regions [6]. Reports show that addressing hypertension awareness by instituting regular community checks of blood pressure is cost-effective and may help reduce cardiovascular complications from hypertension in many resource-poor settings [66].

From our modelling, we estimated about 20.8 million hypertensive cases among people aged at least 20 years in 2010, with a prevalence of 28.0% in both sexes, and men having higher prevalence (30.7%) than women (25.2%). Our prevalence is higher than was previously reported in the 1997 survey, which was based on at least 160/95 mmHg (11.4%) [10]. Twagirumukiza *et al.* [60] reported a prevalence of 18.4% (men 19.4%, women 17.5%) among people aged at least 15 years in Nigeria in 2008. This is quite low compared to our estimates, and may be due to the fact that the prevalence reported for Nigeria was based on a logistic model applied on a single study conducted in south-western Nigeria in 1999, and may therefore not be representative of the overall Nigerian population in 2008 [60,67]. This may also be similar with the prevalence reported by the International Collaborative Study of Hypertension in Blacks

(ICSHIB) in 1995, where an age-adjusted prevalence of hypertension in Nigeria was estimated as 14.5% (14.7% for men and 14.3% for women) [39]. This estimate was also based on a small population group (sample size 1171), and their age-adjusted estimate may not be representative of the overall Nigerian population.

Some recent estimates were reported by Ogah *et al.* [21] with a prevalence of 22.5% for the period 2000–2009, and Ekwunife and Aguwa [68] estimated a prevalence of 22% for the period 1990–2009. These estimates are relatively low in comparison to our current estimates. As noted above, the prevalence reported by Ekwunife and Aguwa may also not be representative of the entire Nigerian population as it was derived from nine studies mainly conducted in south-western Nigeria [68]. However, Ogah *et al.* did review more studies (30 studies), but these studies were selected from 1960 (a period when hypertension was not yet based on cut-off of 140/90 mmHg), and the hypertension criteria used by the authors were not explained in detail.

Meanwhile, the observed higher prevalence in men has also been reported by many African studies having similarities with Nigeria [59]. This may be because the overall mean age from all selected studies was 45.1 years, which is just about a reported 49.4 years mean menopause age among Nigerian women [69], and there is established evidence of a steeper blood pressure increase in men than women before the age of menopause [70]. It may also be linked to socio-economic factors, where men are mostly responsible for family maintenance and finances, and are

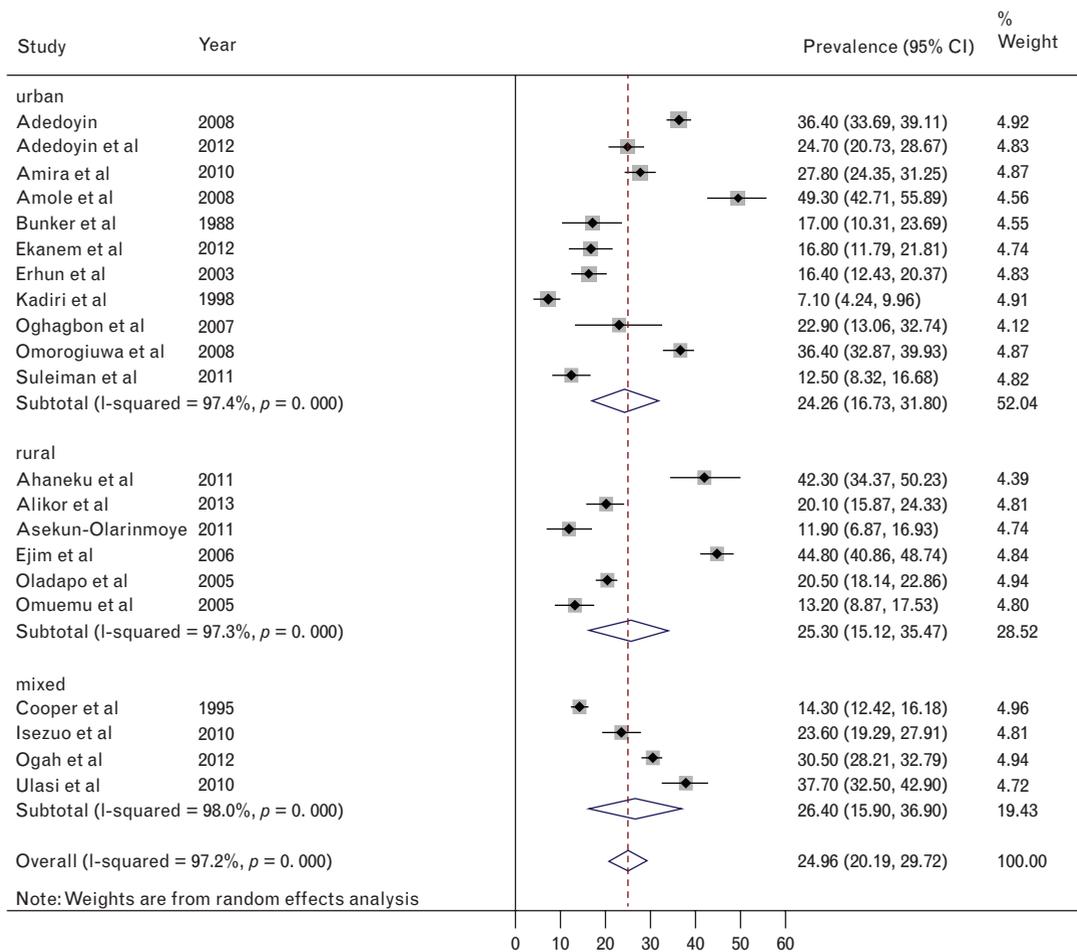


FIGURE 4 Forest plot of crude hypertension prevalence rates among women in Nigeria.

unduly stressed by the need to fulfil these obligations [8]. However, the prevalence reported by the WHO global status report on NCD groups was higher at 42.8% for both sexes, 41.5% in men and 44.0% in women among people aged at least 25 years [7]. There are still concerns over the sources of data and type of modelling used, as experts have reported a possible over-estimation of the prevalence from a rather sophisticated statistical modelling [71,72]; we may therefore need to interpret this with caution.

Our 2030 projections show an increase in hypertension cases and prevalence from the 2010 estimates. With emerging new families gradually adopting smaller family sizes in Nigeria, we assumed there would be no huge difference in fertility rate in Nigeria by 2030. We thus employed the constant fertility variant of the United Nations population projections for Nigeria in 2030 to arrive at our projected number of hypertension cases and prevalence [27]. Our projected increase is a reflection of the overall population growth and ageing in the country, with the absolute number of cases of hypertension almost doubling from 20.8 million in 2010 to 39.1 million in 2030. However, with a marginal increase in prevalence from 28.0 to 30.8%, this may be due to a potentially better and improved nationwide strategy for the management of hypertension, which has thus narrowed the prevalence gap. To the best of our knowledge, there is yet a comparable projected estimate for

hypertension cases and prevalence in Nigeria. However, research findings have shown that the prevalence of hypertension in Nigeria gradually increased from about 8.9% in the 1980s, to 15.0% in the 1990s, and increased considerably to about 22.5% in 2000 [21].

Although we aimed to provide an evidence-based, data-driven and close population representative estimates of the prevalence and cases of hypertension in Nigeria, we could have been constrained by some factors. We acknowledged there could be uncertainties surrounding our estimates, as variations in population structures, diagnostic criteria, blood pressure-measuring protocols, and effects of other health determinants (beyond age of patients) are important factors that need be considered. In addition, even with the increased output of population-based studies on hypertension in Nigeria, the number of studies retained was still relatively low, and despite an overall sample size of 27 122, study sites do not strictly spread evenly across the six geopolitical zones in Nigeria, with many of these studies conducted in the southern part of the country. Furthermore, due to lack of data, we could not provide estimates of the prevalence rates of hypertension according to the JNC classifications, particularly on pre-hypertension or borderline hypertension. One important limitation of this study was our inability to estimate the treatment and control rates of hypertension in Nigeria, which was also due to lack of

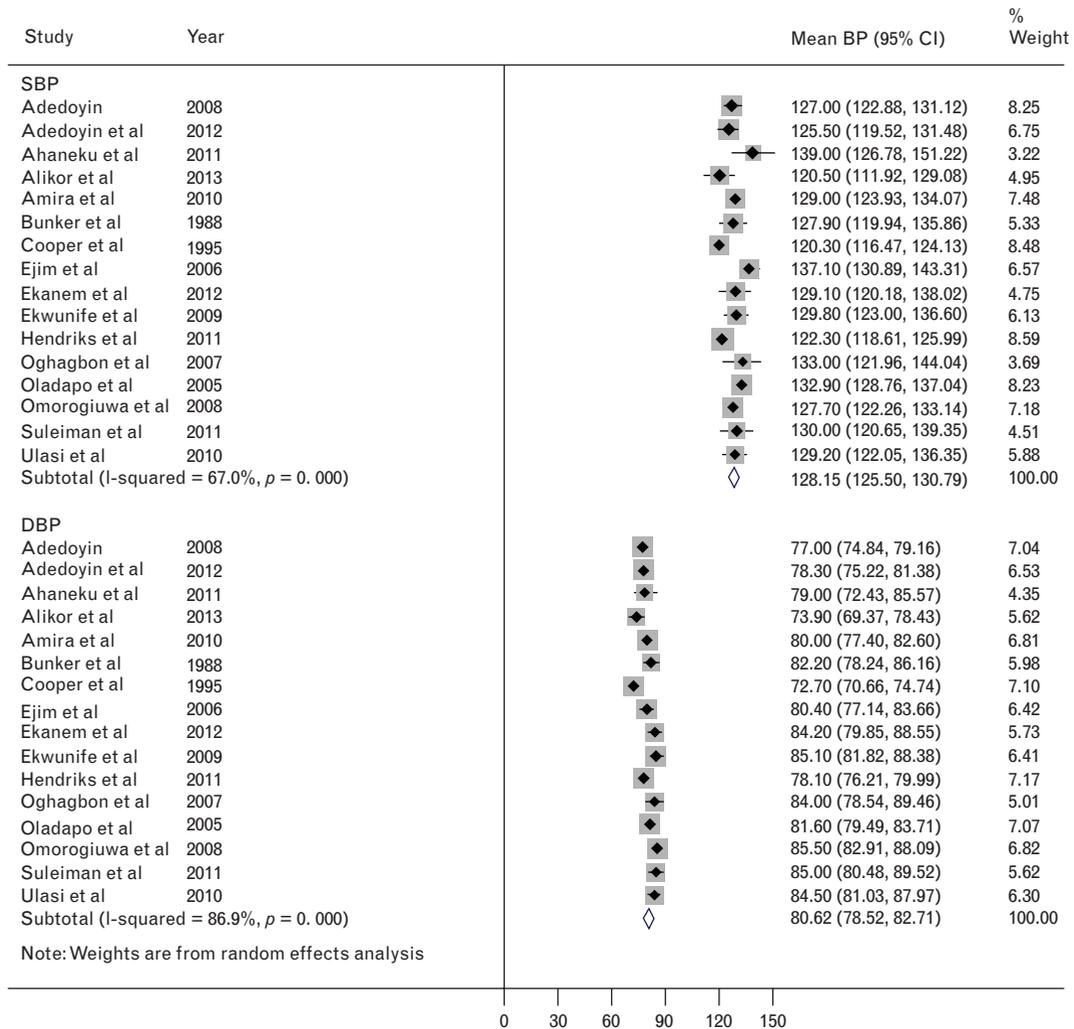


FIGURE 5 Forest plot of mean SBP and DBP in Nigeria.

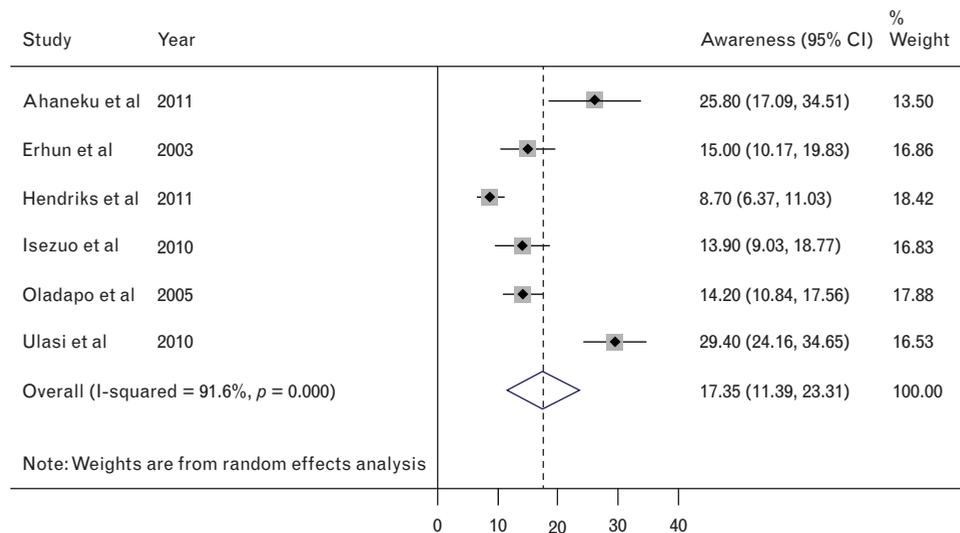


FIGURE 6 Forest plot of awareness rate of hypertension in Nigeria (expressed as percentage of overall cases of hypertension).

TABLE 5. Estimated hypertension prevalence rates and number of cases in Nigeria for 2010

Age (years)	Both sexes			Men			Women		
	Prevalence (%)	Nigerian population (000)	Hypertension cases ^a (000)	Prevalence (%)	Nigerian population (000)	Hypertension cases (000)	Prevalence (%)	Nigerian population (000)	Hypertension cases (000)
20–24	25.8	14535	3749	24.2	7393	1944	17.1	7142	1329
25–29	26.4	12643	3340	25.3	6424	1768	18.6	6219	1256
30–34	27.1	10517	2846	26.5	5358	1543	20.1	5159	1130
35–39	27.7	8237	2283	27.7	4221	1272	21.9	4017	955
40–44	28.4	6400	1817	29.0	3248	1025	23.7	3152	813
45–49	29.1	5345	1554	30.4	2656	877	25.7	2689	752
50–54	29.8	4487	1336	31.8	2183	754	27.9	2304	699
55–59	30.5	3690	1126	33.3	1764	638	30.3	1926	634
60–64	31.3	2976	930	34.8	1433	542	32.9	1543	551
65–69	32.0	2309	739	36.4	1104	437	35.6	1205	467
70–74	32.8	1566	513	38.1	733	304	38.7	832	350
75–80	33.6	909	305	39.9	414	180	42.0	495	226
80+	35.2	598	211	43.7	256	122	49.4	343	184
Total 20+	28.0 (24.6, 31.9) ^b	74213	20750	30.7 (24.9, 33.7)	37187	11406	25.2 (22.7, 31.9)	37026	9346

^aEstimates derived from epidemiological model and based on UN population demographics.
^b95% CI.

data. This could have been an important indicator of the response to hypertension in Nigeria. We, however, believe an estimate of the awareness rate of hypertension in Nigeria, which we provided, may relatively reflect the

response to this growing burden of hypertension in the country. Finally, across retained studies, data on age and sex-specific prevalence, including corresponding data on mixed, urban and rural settings, which are vital comparative indices in any study, were not always provided (see Table 3 for overall study characteristics).

Public health response to hypertension in Nigeria

As of 2013, Nigeria still does not have a comprehensive policy for NCDs [73]. The recent communique of the National Health Council held in August 2013 points to an approval of this policy [74], yet there are still doubts on when this may be implemented. At health service delivery level, Nigeria invariably still lacks nationwide health services coverage for the awareness, diagnosis, control and treatment of hypertension [21]. In many health centres, blood pressure measurements and drug prescriptions for hypertension are not in line with the standard protocols, with poor adherence to medications often reported following complicated prescriptions [8]. The lack of standard health services has translated into poor record keeping and lack of reliable data and statistics needed to make essential health decisions on hypertension [24]. Many researchers find it difficult assessing data on hypertension and many related health issues in Nigeria, with this also leading to poor quality of research in the country [24,75].

Reports show that consumption of dietary salt is generally high in the country [9,76], and due to busy working schedules, people now consume more processed foods, and often prefer to eat from fast food restaurants [9]. Population strategies aimed at reducing salts and fats consumption and encouraging better consumption of fruits and vegetables have been shown to be very cost-effective (WHO) [77]. Experts have called for a countrywide adaptation of the Dietary Approach to Stop Hypertension (DASH) promoted by the United States National Heart, Lung and Blood Institute, as this has better dietary plans

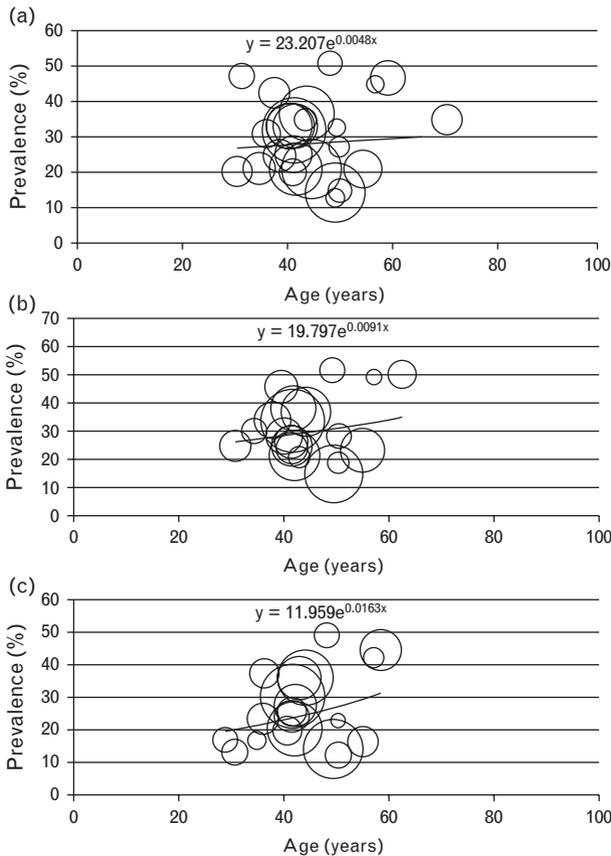


FIGURE 7 Epidemiological model showing relationship between age and crude prevalence of hypertension in Nigeria in 2010, with size of bubble corresponding to sample size. (a) Both sexes; (b) men; (c) women.

TABLE 6. Projected hypertension prevalence rates and number cases in Nigeria for 2030

Age (years)	Both sexes			Men			Women		
	Prevalence (%)	Nigerian population (000)	Hypertension cases ^b (000)	Prevalence (%)	Nigerian population (000)	Hypertension cases (000)	Prevalence (%)	Nigerian population (000)	Hypertension cases (000)
20–24	27.7	25208	6983	25.0	12667	3163	21.2	12251	2598
25–29	28.8	20922	6017	27.0	10562	2848	23.1	10184	2353
30–34	29.9	17163	5124	29.1	8687	2530	25.2	8366	2105
35–39	31.0	14284	4428	31.5	7235	2276	27.4	6975	1912
40–44	32.2	12252	3943	34.0	6176	2098	29.9	5997	1791
45–49	33.4	10520	3515	36.7	5246	1925	32.5	5173	1682
50–54	34.7	8629	2993	39.6	4227	1675	35.4	4280	1516
55–59	36.0	6699	2413	42.8	3204	1371	38.6	3361	1297
60–64	37.4	4965	1856	46.2	2300	1063	42.0	2530	1063
65–69	38.8	3586	1392	49.9	1605	801	45.8	1851	847
70–74	40.3	2311	931	53.9	991	534	49.9	1209	603
75–80	41.8	1215	508	58.2	492	286	54.3	648	352
80+	45.1	622	281	67.9	236	160	64.4	335	216
Total 20+	30.8 (24.5–33.7) ^a	126788	39066	32.6 (27.3–38.2)	63628	20731	29.0 (21.9–32.2)	63160	18335

^a95% CI.^bEstimates derived from epidemiological model and based on United Nations population demographics.

rich in fruits and vegetables, whole grains and low-fat dairy products [73]. Furthermore, tobacco industry is thriving in Nigeria and is a known factor for resistant hypertension [78]. Recently, the National Tobacco Control Bill was passed to the Nigerian National Assembly, with experts calling for strict legislations on tobacco products, including increased

taxation and ban on public smoking [79,80]. Apart from the Lagos State, which recently banned smoking in public places, this generally has been difficult to implement in other parts of Nigeria, possibly due to the influence of tobacco companies on the Nigerian economy [79,81].

In conclusion, our findings suggest a high prevalence and low awareness of hypertension in Nigeria. With heterogeneities from various study methods and protocols, coupled with poor data record keeping, we still cannot say with certainty the exact prevalence of hypertension in Nigeria. Hypertension remains a modifiable cardiovascular risk, meaning that with adequate public health response and countrywide intervention, the burden can be reduced. There is a need for more research on hypertension and risk factors (especially from the Northern parts of the country), proper health record keeping at all levels, update of available data at national levels, all towards ensuring an improved policy response to the awareness, control, treatment and overall management of hypertension in Nigeria.

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Ethical approval: Not required.

Authorship declaration: All co-authors designed and conducted the study and contributed to the writing of the paper.

Conflicts of interest

FAO is a health systems and policy consultant to the Health Reform Foundation of Nigeria (HERFON). For the remaining authors, no conflicts of interest are declared.

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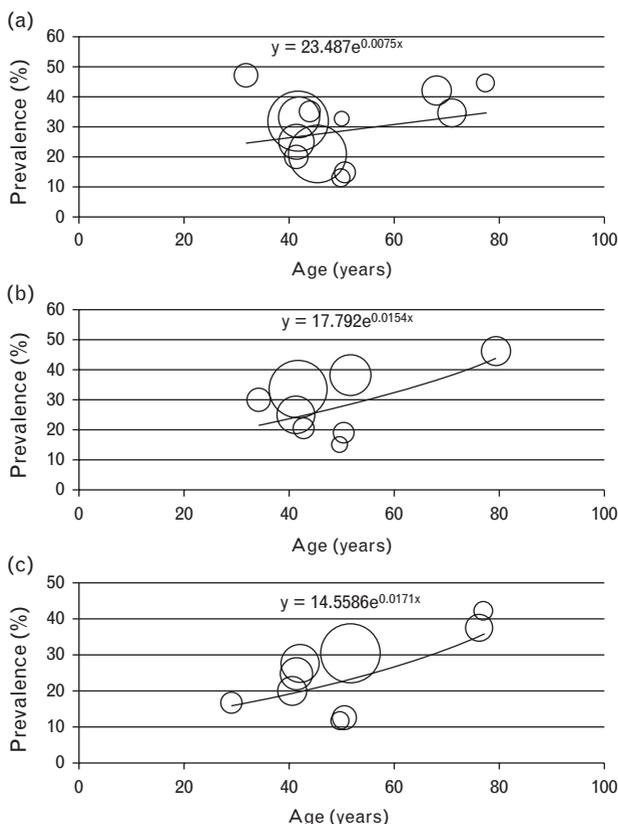


FIGURE 8 Epidemiological model showing relationship between age and crude prevalence of hypertension in Nigeria in 2030, with size of bubble corresponding to sample size. (a) Both sexes; (b) men; (c) women.

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Reviewers' Summary Evaluations

Reviewer 1

Based on 27 rigorously selected studies performed after 1980, and using the current definition of hypertension, the authors estimated that 28% of the adult Nigerian population has hypertension, with slightly higher prevalence among urban than rural dwellers. Unfortunately information on antihypertensive treatment and BP control was lacking in most of the selected studies, but their prevalence can be assumed to be low in view of the mere 17% awareness rate of hypertension. The authors envisage an increase of the prevalence of hypertension to 31% in 2030, but this

is only based on demographics and does not consider the potential influence of hopefully preventive lifestyle changes.

Reviewer 3

The paper by Adeloye and coworkers provides, through the use of a meta-analytic approach, comprehensive information on the epidemiological profile of hypertension in Nigeria. Strengths of the paper are its rigorous meta-analytic approach as well as the clear data discussion. Intrinsic limitations refer to the discrepancy between the different studies meta-analyzed, the methods used to assess blood pressure and the lack of data on prehypertension.