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Review Article

Prevalence of Prehypertension in Nigeria: a Systematic Review and Meta-analysis

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Abstract

Background: Prehypertension is a low blood pressure state associated with an elevated risk of cardiovascular disease and the development of hypertension. Everyone is concerned about the rising global burden of hypertension and prehypertension. The goal of this study was to determine the prevalence of prehypertension in Nigeria.

Methods: Studies were chosen based on predefined criteria after doing online searches of Google Scholar, PubMed, and the African Index Medicus. The meta-analysis comprised 21 studies with a total of 25839 participants that were completed between 2011 and 2021.

Results: The pooled prevalence of prehypertension in Nigeria was found to be 34% (95% CI: 30%-40%), corresponding to 41.4 million adults. Males have a higher prehypertension prevalence of 39.1% (95% CI: 30.9%-47.6%) than females, with a prevalence of 28.5% (95% CI: 21.2%-36.4%). Between the sexes, there were no statistically significant differences. While the North-East had the lowest rate of prehypertension (18%), the North-West had the greatest rate of prehypertension (43%), indicating a statistically significant differential between the regions. However, when compared to metropolitan settlements (37%), rural areas have a pooled frequency of 32 percent.

Conclusion: There were no statistically significant differences in gender or between rural and urban communities. There was, nevertheless, a statistically significant difference across the regions. Prehypertension is common in Nigeria, and it indicates a future risk of hypertension and other cardiovascular disorders.

Keywords: Prehypertension, Prevalence, Systematic review, Meta-analysis, Nigeria

Introduction

Blood pressure that is abnormally high is known as hypertension. From a systolic blood pressure (SBP) of 115 mmHg and a diastolic blood pressure (DBP) of 75 mmHg, the risk of cardiovascular disease grows in a log-linear pattern, with the risk of cardiovascular-related death doubling every 20 mmHg and 10 mmHg increase in SBP and DBP, respectively (1). Despite the constant risk of rising blood pressure, identifying a cut-off number is critical for clinical and public health interventions to establish a threshold of action (2). This was described as an SBP of 140 mmHg and/or a DBP of 90 mmHg.

Given the long-term relationship between blood pressure and cardiovascular risk, it's only natural to establish additional low-blood pressure thresholds to warn doctors and public health officials to implement low-level measures to reduce cardiovascular risk. Prehypertension (PHTN) is such a category. It is a borderline high-risk blood pressure status defined as SBP of 120-139 mmHg and/or DBP of 80-89 mmHg (2). When compared to normotensive patients with a 10% yearly progression rate to hypertension, prehypertension is associated with a fourfold greater chance of developing hypertension (3). Prehypertension is related with a 200 percent increase in cardiovascular disease incidence compared to blood pressure less than 120/80mmHg, in addition to the high chance of conversion to hypertension (2).

High blood pressure has becoming more prevalent over the world. In 1975, there were 594 million persons with high blood pressure, according to a pooled study of 1479 research from 174 countries with 19.1 million participants. In 2015, this number grew to 1.13 billion individuals, with the majority of the rise occurring in developing countries. Eighty-eight percent (88%) of deaths caused by high blood pressure now occur in underdeveloped countries (4). Prehypertension was shown to be 38 percent common in a meta-analysis of 242 322 people from 11 countries, including Nigeria (5).

The prevalence of prehypertension was determined to be 30.9 percent in a recent meta-analysis of 9 studies completed in Nigeria between 1995 and 2020, involving 16, 241 people (95 percent CI: 22.0-39.7). However, the analysis only included studies from four of the country's six geopolitical zones. In addition, no sex-specific prevalence of prehypertension was reported (6). This study aimed to determine the sex-specific prevalence of prehypertension across the 6 geo-political zones as well as in urban and rural settlements of Nigeria.

Materials and methods

Study Area

Nigeria is a western African country with a population of over 250 ethnic groups and a land area of 923,769 square kilometers (7). It is organized into six geopolitical zones or regions, with 36 states and a capital. In 2021, the population is expected to be 211.4 million. About 43.4% of the population was under the age of 14. In addition, 53.9 percent of the population was aged 15 to 64 years old. Only 2.8 percent of the population was above 65 years old (8). Figure 1 shows the map of the country's geopolitical zones.

Inclusion and exclusion criteria

We considered community-based studies conducted on Nigeria's adult population (over the age of 18). SBP of 120-139 mmHg and/or DBP of 80-89 mmHg were used to characterize prehypertension in the studies. We omitted studies involving people under the age of 18, studies involving pregnant women, and all trials conducted in hospitals.

Study search strategy

Google Scholar, PubMed, Global, and African Index Medicus were the online databases used. The terms ‘prehypertension,' ‘pre-hypertension,' and ‘hypertension' were used in the search. For each word containing the word "Nigeria," the search was repeated. The searches took place between March 4th and March 15th, 2021. Two reviewers (MAB and MM) independently screened the abstracts and titles of the papers, and studies were selected and excluded based on predetermined criteria. The full-text papers were then screened independently by the same academics in order to choose studies for qualitative and quantitative analyses.

Qualitative Analysis of the Included Studies

A modified version of the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Research Reporting Prevalence Data was used to assess the methodological quality of the included studies (9). The item was decreased from nine to six questions, with each question receiving a score of one for a yes and zero for a no. The maximum possible score is six. If a study received a minimum of five points, it was considered good quality, and if it received less than five points, it was considered poor quality. Two reviewers (AIH and MM) worked independently on the assessment, with AHY resolving any differences. The modified tool used in critical assessment of the included studies is shown in Table 1. According to a recent meta-analysis of studies completed in Nigeria, the minimal sample size for ranking a study as a ‘yes' was 323, calculated using the Epitools online calculator (10) and assuming a 30-percent estimated prevalence (6). The quantitative analysis includes only studies that were assessed to have good methodological quality.

Data Extraction and Quantitative Analysis

Two reviewers worked independently to obtain data (MAB and AHY). Prevalence of prehypertension, sample size, settlement (urban/rural), state and location of study, study year, mean age, and sex composition of study participants were all extracted from the studies. For statistical computing, data was loaded into Excel and then imported into the R statistical environment, version 4.1.0 (11).

The Metafor Package (12) was used to fit the Random Effects Model for pooling prevalence and the Mixed Effects Model for meta-regression using the inverse variance method with correction of pooled estimate and its variance using Sidik-Jonkman's estimator for between study heterogeneity (13).

- Influence and Heterogeneity Analyses

There were three degrees of inquiry into heterogeneity. Individual studies were initially looked into for influences, which were defined as follows:

1. The hat value, which is the standardized difference between each study's reported prevalence and the pooled prevalence, was calculated.
2. Based on rstudent, a normalized distance between each study's projected prevalence and the pooled prevalence.
3. Cook's distance is the distance between the aggregated prevalence when each study is included and when it is excluded.
4. Based on difference in fits (diffits), which is a distance in standard deviation units between pooled prevalence with the study included and when the research is omitted. The cutoff values were chosen using the R metafor package. In the generated influence graphs, studies that met these cut-off values were highlighted in red (14).

On a second level, gosh analysis, which is also part of the metafor package, was used to look for probable clusters in the studies that were included.

On a third level, a metaregression model was fitted using characteristics of the included studies as predictors to see how much of the computed variability can be attributable to study-level factors including sex composition, geopolitical region, settlement, mean age of the subjects, and sample size.

Prediction Intervals built in the meta R package (15) have been reported to help interpret tau2 and I2 as indicators of between-study heterogeneity (16).

- Publication Bias Assessment

The Funnel plot was used to visually evaluate for probable publication bias, which occurred when papers indicating low prevalence were not published and hence were not included in the meta-analysis. Eggar and colleagues (17) used a formal regression technique to test funnel plot asymmetry.

Search Results

The results of the search strategy can be seen in Figure 2.

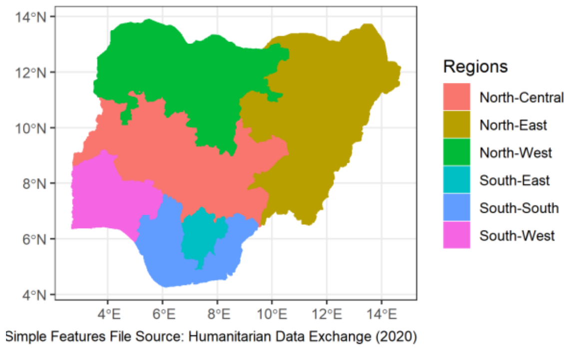

Figure 1. Geo-Political Zones in Niger

Table 1. Modified JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data

Question	Yes = 1 No = 0
1. Was the sample frame appropriate to address the target population?	
2. Were study participants sampled in an appropriate way?	
3. Was the sample size adequate?	
4. Were the study subjects and the setting described in detail?	
5. Were valid methods used for the identification of the condition?	
6. Was the condition measured in a standard, reliable way for all participants?	
Total score	

Results

Methodological features and the Critical Appraisal of the Included Studies

Out of the 63 studies included in the qualitative analysis, only 21 studies were judged to be of good quality and included in the quantitative analysis. Table 2 shows the result of the qualitative analysis.

Characteristics of the Studies Included in the Quantitative Analysis

Twenty-one studies with a total of 25839 participants met the criteria for inclusion and had sufficient methodological quality to be included in the meta-analysis. The research was carried out between 2011 and 2021. There were 7 studies from the South-West region, 6 studies from the South-South, 3 studies from the South-East, 3 studies from the North-Central, one study from the North-West region and one study was conducted in all the six geopolitical regions. There were seven studies in rural areas, thirteen studies in urban areas, and one research that included both rural and urban areas. The average age of the study participants was 40 years in the South-South studies and 47 years in the South-East investigations. The South-West had the most participants in the study (9907), while the North-East had the fewest (1070). Studies from the country's southern areas are often larger in size and contain older individuals (Figures 3 and 4).

Fitting the Meta-analytic Model

Random Effects Model was fitted using the inverse variance method with correction of pooled estimate and its variance using Sidik-Jonkman's estimator for between study heterogeneity. Prevalence was transformed using an arcsine transformation. Figure 5 shows the forest plot of the model.

In Nigeria, the overall prevalence of prehypertension was 34 percent (95% CI: 30-40%). According to the United Nations' most recent statistics (8), Nigeria had an estimated 41.4 million adult prehypertensive persons. The random meta analytic model had a P-value of 0.001. The total between-study heterogeneity (tau2) was estimated to be 0.02 (S.E. = 0.005). The percentage of heterogeneity between-studies not explained by sampling error (I2) was 98.6%. The test for heterogeneity revealed Q (df= 24) = 1600, with a P-value of 0.001, showing significant heterogeneity among the studies. The R program meta created a more reasonable prediction interval ranging from 10% to 61 percent. This range shows the prehypertension prevalence rates that future investigations in Nigeria might uncover.

Analysis of Between Study Heterogeneity

- Outliers and Influencers

An investigation of likely outliers and influencers was conducted to explain the significant variation. Figure 6 displays the model's radial plot, which reveals no noticeable outliers. The influence analysis plots in Figure 7 corroborate this.

- Gosh Analysis

The probability of clusters within the included studies was investigated using the metafor R package's Gosh analysis. There are no clusters in Figure 8. The included studies did, in fact, form a single cluster with significant heterogeneity.

- Meta-regression using Studies Characteristics as Predictors

The geography of the study was used as the sole predictor, followed by the region, settlement, mean age, and sample size of the included studies. Tau^2 declined from 0.017 in the model without predictors to 0.002 in the model with predictors (a 91% drop). The change in I^2 is also considerable, going from 98.6%, which indicates significant heterogeneity, to 70.3 percent, which indicates moderate heterogeneity. This suggests that differences in study characteristics account for the majority of the heterogeneity between studies. Figure 9 shows the relative changes in the two heterogeneity metrics after fitting the meta-regression models.

Analysis of Publication Bias

The funnel plot of the model is shown in Figure 10. In the plot, there was no noticeable imbalance. The visual assessment of the funnel plot was confirmed by a formal test for plot asymmetry (regression test), which was not statistically significant (P value = 0.079).

Sex-Specific Prevalence of Prehypertension in Nigeria

As seen in Figure 11, males had a higher prehypertension prevalence of 39.1% (95% CI: 30.9%-47.6%) than females, with a prevalence of 28.5% (95% CI: 21.2%-36.4%). The difference was not statistically significant (P = 0.066).

Prevalence of Prehypertension in Nigeria by Geo-political Region

Figure 12 shows the prevalence of prehypertension in Nigeria by geopolitical zones. The North-East had the lowest prevalence of prehypertension, at 18%. The North-West, with a prevalence of 43%, had the highest rate of prehypertension. The model's P value is 0.003, showing a statistically significant variation in prehypertension prevalence among the six geopolitical regions.

Difference in Prevalence of Prehypertension between Urban and Rural Settlements in Nigeria

The pooled prevalence in rural settings was 32%, while the pooled prevalence in urban settings was 37%, as shown in Figure 13. The difference (P = 0.307) was not statistically significant.

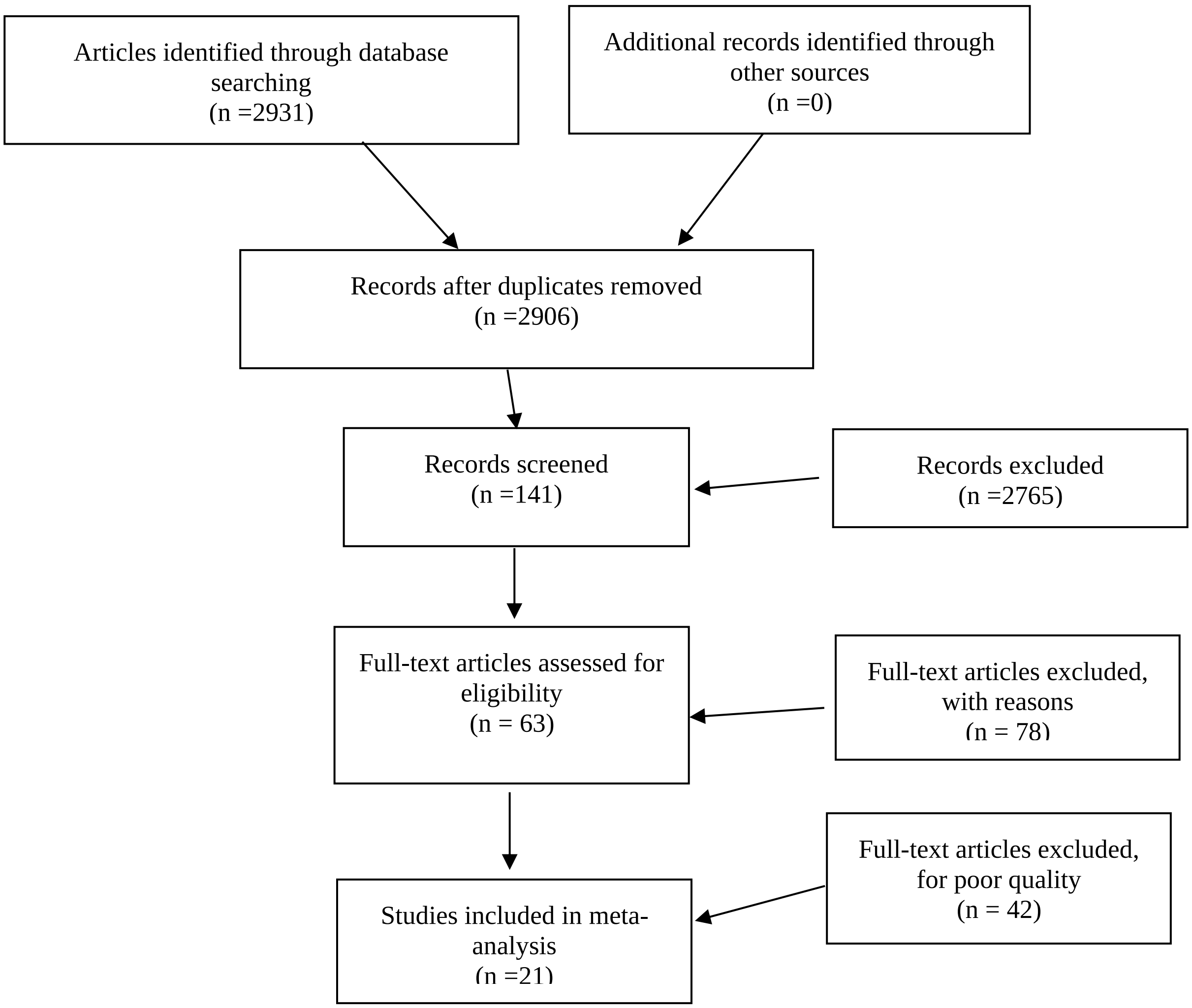

Figure 2. Results of the Search Strategy

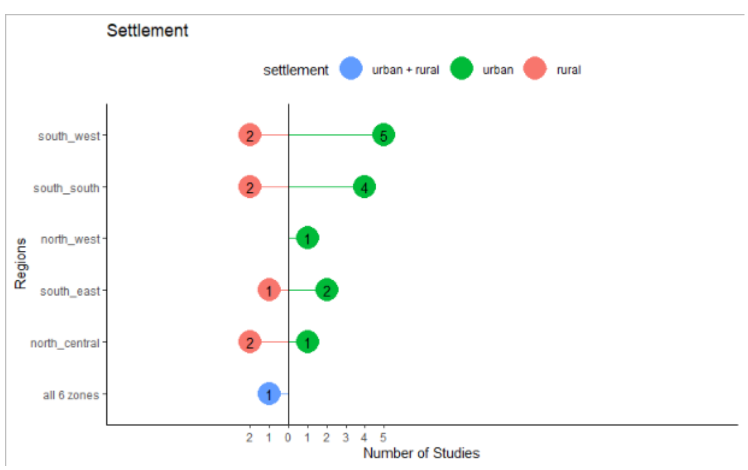

Figure 3. Number of Included Studies by Region and Settlement

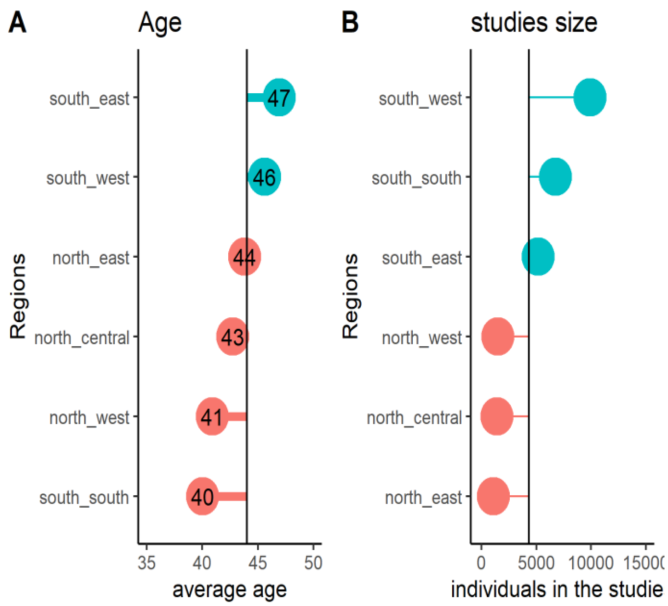

Figure 4. Mean Age and Number of Subjects in the Included Studies by Region

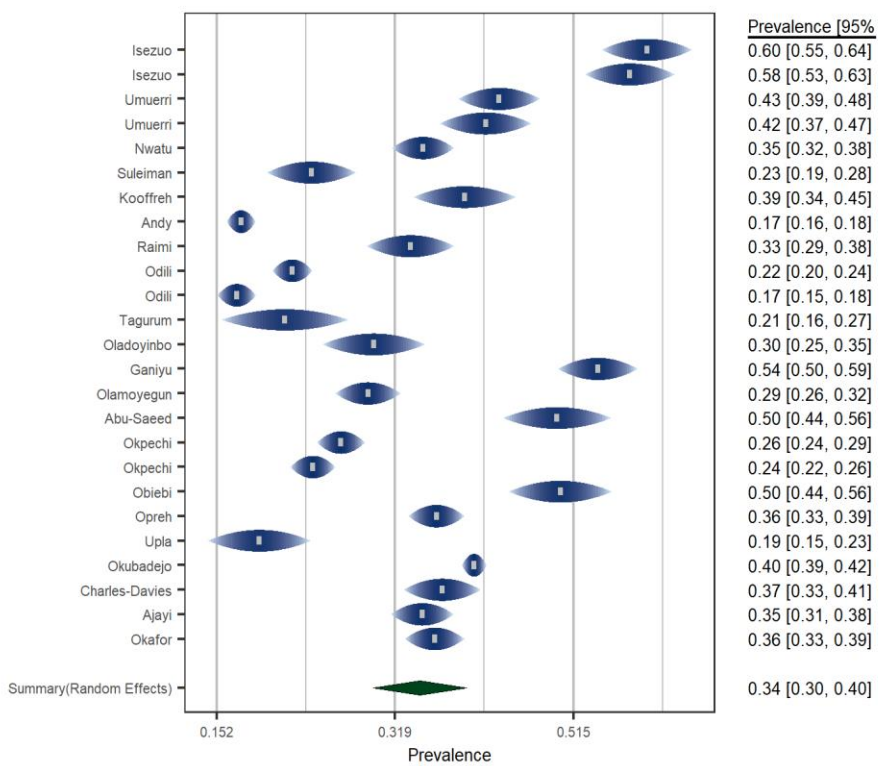

Figure 5. Forest plot

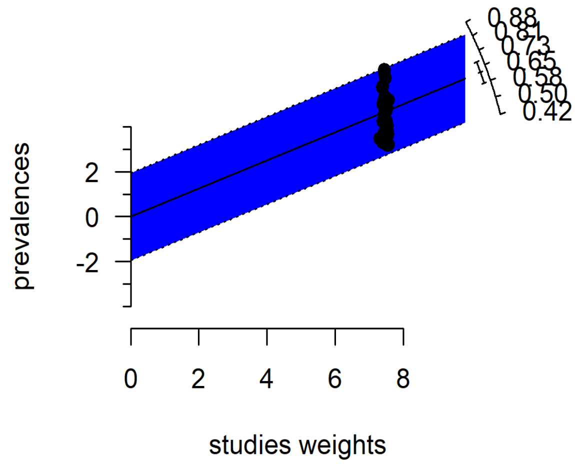

Figure 6. Radial plot of the model

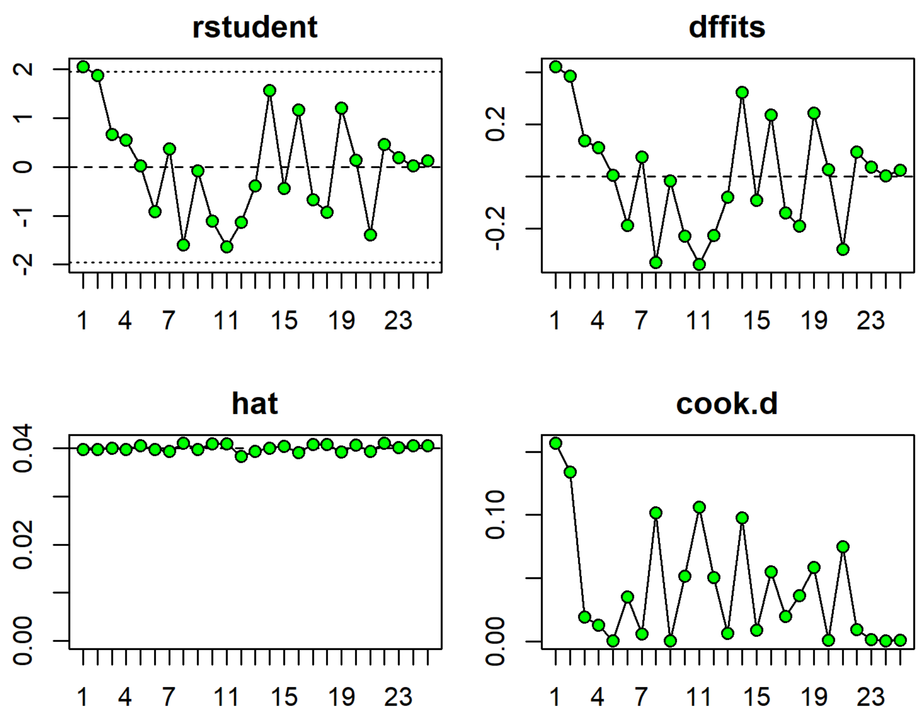

Figure 7. Influence analysis of the model

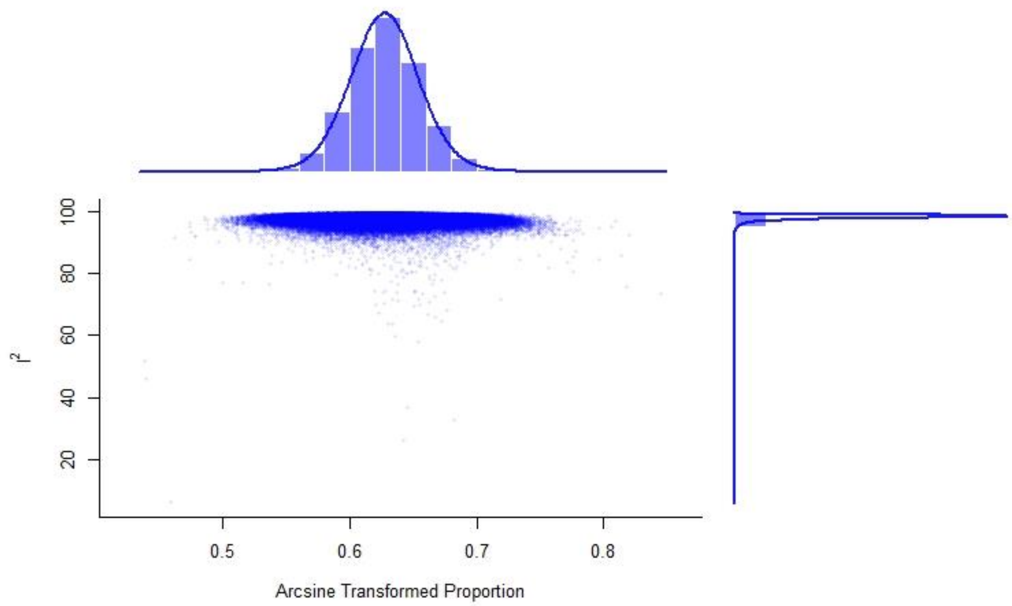

Figure 8. Gosh Plot of the Model

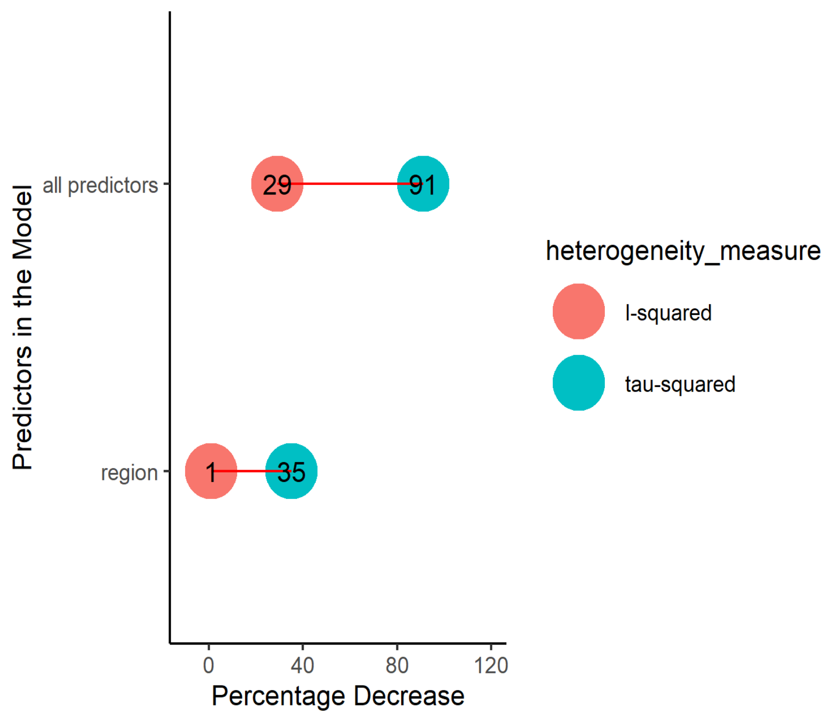

Figure 9. Comparison of Change in the Heterogeneity Measures after Fitting Meta-regression Models

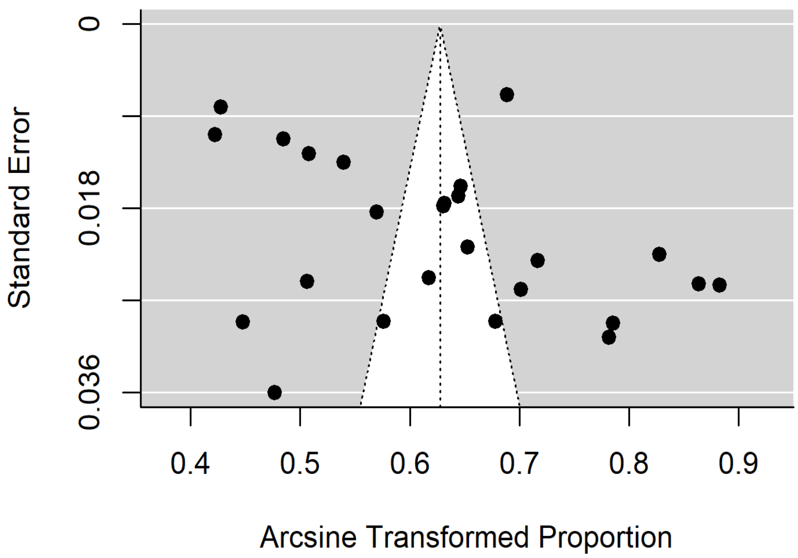

Figure 10. Funnel Plot

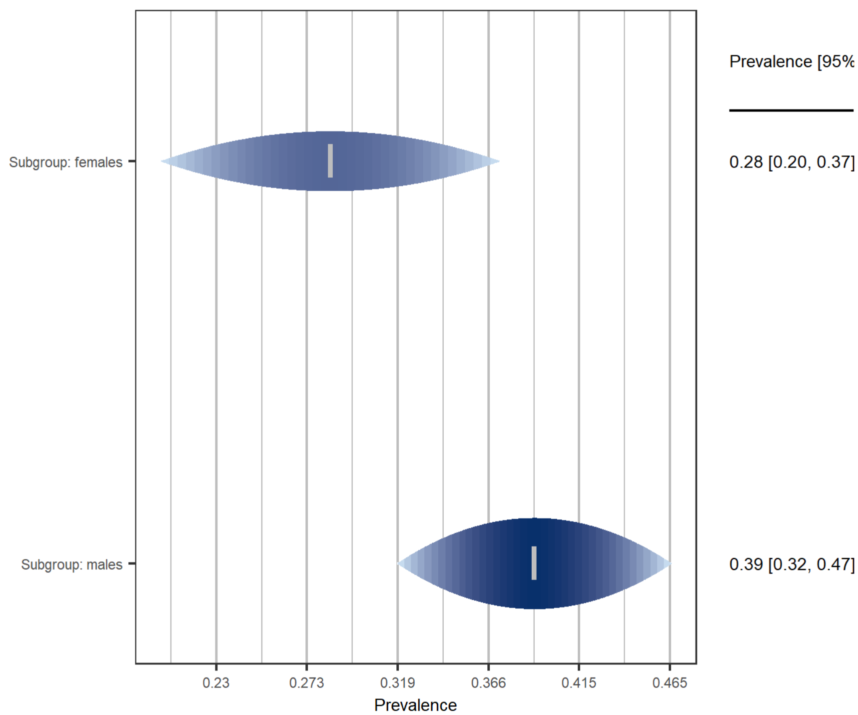

Figure 11. Prevalence of Prehypertension in Males and Females

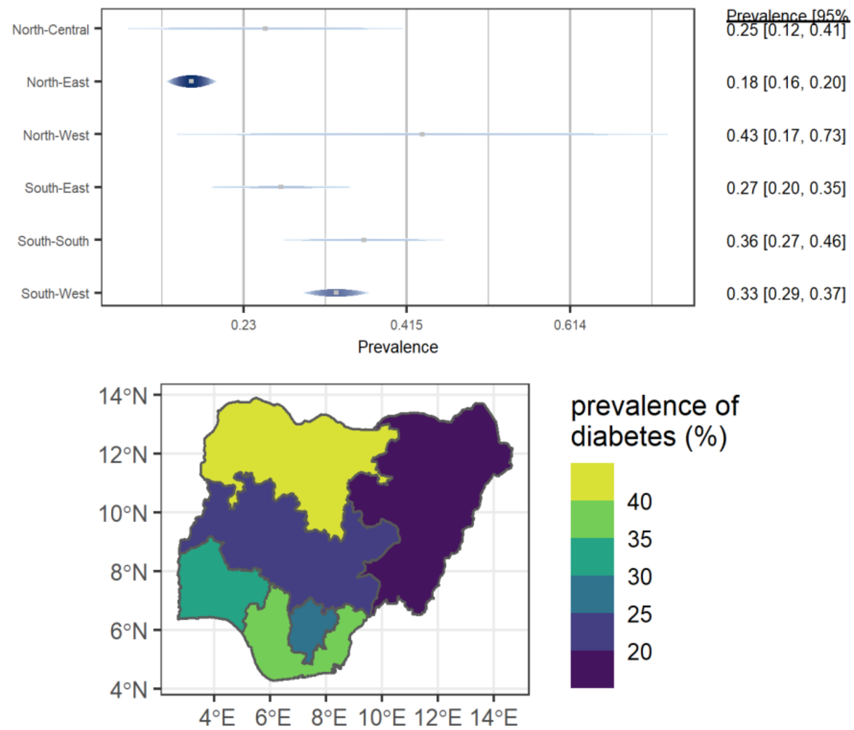

Figure 12. Forest Plot and Map of prevalence of Prehypertension by region

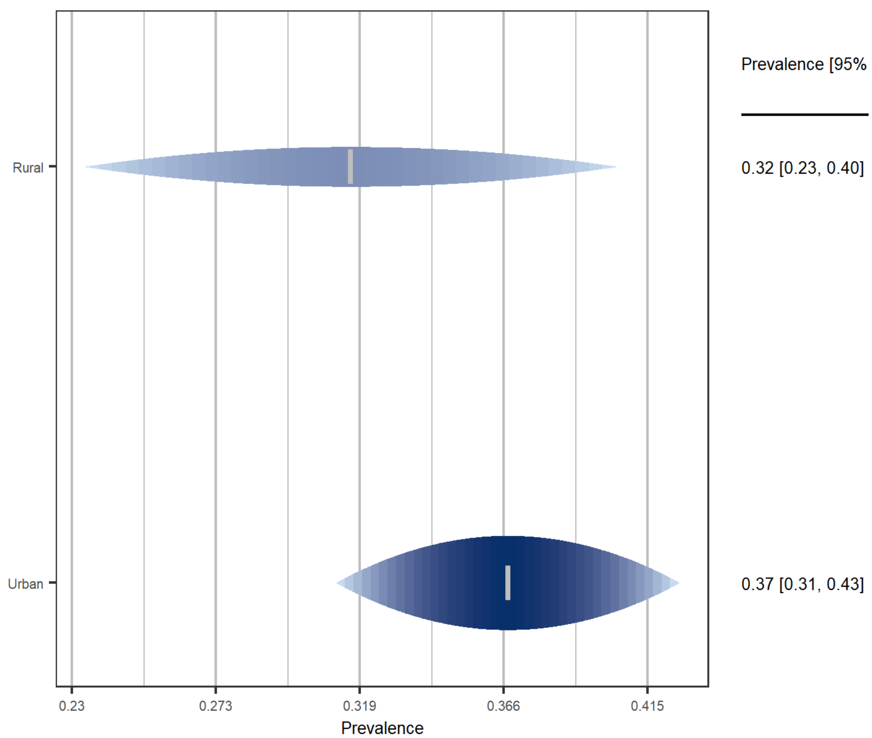

Figure 13. Forest plot of prevalence by rural and urban settlements

Table 2. Characteristics of studies with quality appraisal results

First_Author	Study_Year	Residence	State	Region	Sample Size	Scoring Items						Total Score	Quality
						sample frame	sampling	Sample size	Subject /setting	Valid method	Reliable methods		
Isezuo [18]	2011	urban	Sokoto	North_West	782	1	1	1	1	1	1	6	Good
Okafor [19]	2011	urban	Enugu	South_East	898	1	1	1	1	1	1	6	Good
Wokoma [20]	2011	rural	Rivers	South_South	152	0	0	0	1	1	1	3	Poor
Andy [21]	2012	rural	Akwa Ibom and Cross rivers	South_South	3869	1	0	1	1	1	1	5	Good
Nwazor [22]	2012	urban	Ebonyi	South_East	215	0	0	0	1	1	1	3	Poor
Adejumo [23]	2013	urban	Lagos	South_West	300	0	0	0	1	1	1	3	Poor
Charles-Davies [24]	2013	urban	Ibadan	South_West	534	1	1	1	1	1	0	5	Good
Makusidi [25]	2013	urban	Sokoto	North_West	535	0	0	1	1	1	1	4	Poor
Okpechi [26]	2013	urban	Abia	South_East	2983	1	1	1	1	1	1	6	Good
Suleiman [27]	2013	urban	Bayelsa	South_South	400	1	1	1	1	1	1	6	Good
Abah [28]	2014	urban	Plateu	North_Central	200	0	0	0	1	0	1	2	Poor
Abu-Saeed [29]	2014	urban	Kwara	North_Central	270	1	1	0	1	1	1	5	Good
Adamu [30]	2014	urban	Sokoto	North_West	298	0	0	0	1	1	1	3	Poor
Ale [31]	2014	urban	Lagos	South_West	101	0	0	0	1	1	1	3	Poor
Ganiyu [32]	2014	rural	Delta	South_South	500	1	1	1	1	1	0	5	Good
Okafor [33]	2014	rural	Anambra	South_East	137	0	0	0	1	1	1	3	Poor
Egbuonu [34]	2015	urban	Abia	South_East	200	0	0	0	1	1	0	2	Poor
Egbi [35]	2015	urban	Bayelsa	South_South	231	0	0	0	1	1	1	3	Poor
Guwatudde [36]	2015	urban	Abuja	North_Central	163	0	0	0	1	1	1	3	Poor
Okwounu [37]	2015	urban	Abia	South_East	389	0	0	1	1	1	1	4	Poor
Oladoyinbo [38]	2015	urban	Ogun	South_West	300	1	1	0	1	1	1	5	Good
Tagurum [39]	2015	rural	Plateu	North_Central	195	1	1	0	1	1	1	5	Good
Uwah [40]	2015	urban	Akwa Ibom	South_South	393	0	0	1	1	1	1	4	Poor
Adeoye [41]	2016	urban	Ibadan	South_West	352	0	0	1	1	1	1	4	Poor
Ajayi [42]	2016	urban	Ibadan	South_West	806	1	1	1	1	1	1	6	Good
Ayanniyi [43]	2016	urban	Not reported	South_West	356	0	0	1	1	1	1	4	Poor
Kooffreh [44]	2016	urban	Cross river	South_South	300	1	1	0	1	1	1	5	Good
Mmom [45]	2016	urban	Rivers	South_South	201	0	0	0	1	1	0	2	Poor
Olamoyegun [46]	2016	urban	Ekiti	South_West	750	1	1	1	1	1	1	6	Good
Ononamadu [47]	2016	mixed	Anambra	South_East	912	0	0	1	1	1	1	4	Poor
Aladeniyi [48]	2017	urban	Ondo	South_West	4844	0	0	1	1	1	1	4	Poor
Ayodele [49]	2017	urban	Osun	South_West	131	0	0	0	1	1	1	3	Poor
Ejike [50]	2017	urban	Mixed	South_East	1610	0	0	1	1	1	1	4	Poor

Nwatu [51]	2017	rural	Enugu	South_East	824	1	1	1	1	1	1	6	Good
Ambakederemo [52]	2018	urban	Bayelsa	South_South	168	0	0	0	1	1	1	3	Poor
Bello-Ovosi [53]	2018	urban	Kaduna	North_West	181	0	0	0	1	1	1	3	Poor
Dokunmu [54]	2018	urban	Ogun	South_West	182	0	0	0	1	1	1	3	Poor
Egbi [55]	2018	rural	Bayelsa	South_South	131	0	0	0	1	1	1	3	Poor
Ibuaku [56]	2018	rural	Delta	South_South	432	0	0	1	1	1	0	3	Poor
Nkechi [57]	2018	urban	Rivers	South_South	304	0	0	1	1	1	1	4	Poor
Ofori [58]	2018	rural	Rivers	South_South	389	0	0	1	1	1	1	4	Poor
Olatona [59]	2018	urban	Lagos	South_West	503	0	0	1	1	1	0	3	Poor
Shittu [60]	2018	urban + rural	Oyo	South_West	6915	0	0	1	1	1	1	4	Poor
Wordu [61]	2018	urban	Rivers	South_South	215	1	0	0	1	1	1	4	Poor
Adelowo [62]	2019	urban	Abuja	North_Central	417	0	0	1	1	0	0	2	Poor
Adenrele [63]	2019	urban	Abuja	North_Central	417	0	0	0	1	0	0	1	Poor
Ajayi [64]	2019	urban	Ekiti	South_West	426	0	0	1	1	0	0	2	Poor
Obiebi [65]	2019	urban	Delta	South_South	296	1	1	0	1	1	1	5	Good
Okubadejo [66]	2019	urban	Lagos	South_West	5365	1	1	1	1	1	1	6	Good
Yakubu [67]	2019	urban	All 36 states	all the six geo-political zones	3013	1	1	1	1	0	0	4	Poor
Banigbe [68]	2020	urban + rural	Benue	North_Central	6538	0	0	1	1	1	0	3	Poor
Dada [69]	2020	urban	Ekiti	South_West	300	0	0	0	1	1	1	3	Poor
Odili [70]	2020	urban + rural	6 states	all 6 zones	4192	1	1	1	1	1	1	6	Good
Odunaiya [71]	2020	urban	Ibadan	South_West	316	0	0	0	1	1	1	3	Poor
Olaitan [72]	2020	urban	Plateu	North_Central	283	0	0	0	1	1	0	2	Poor
Olawade [73]	2020	rural	Gombe	North_East	78	0	0	0	1	1	0	2	Poor
Raimi [74]	2020	rural	Ogun	South_West	412	1	0	1	1	1	1	5	Good
Umuerri [75]	2020	urban	Delta	South_South	852	1	0	1	1	1	1	5	Good
Upla [76]	2020	rural	Nasarawa	North_Central	299	1	1	1	1	1	1	6	Good
Wada [77]	2020	rural	Osun	South_West	138	0	0	0	1	1	0	2	Poor
Opreh [78]	2021	rural	Osun	South_West	1012	1	1	1	1	1	1	6	Good

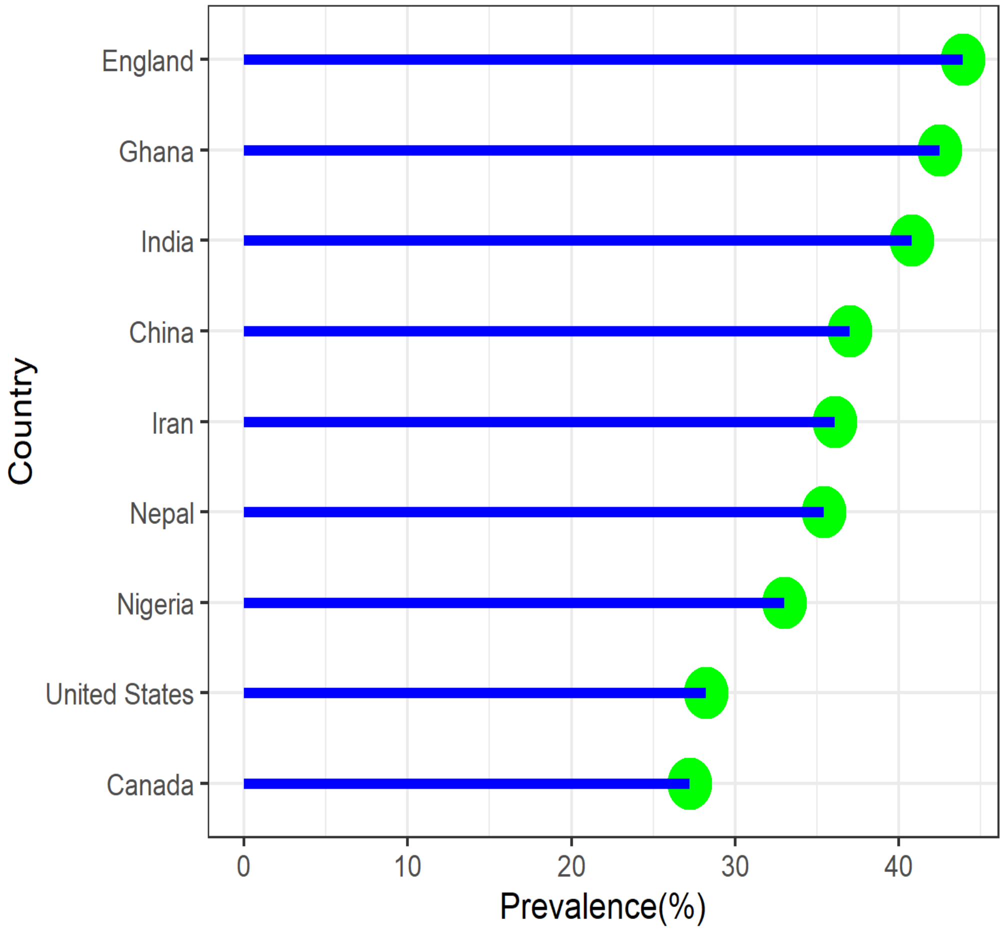

Figure 14. Prevalence of Prehypertension in Selected Countries

Discussion

This study's pooled estimate of prehypertension prevalence in Nigeria, 34% (95% CI: 30-40%), is close to but more precise than a recent meta-analysis in the country, which reported a prevalence of 30.9% (95% CI: 22.0-39.7%) (6). The difference in precision between the two meta-analyses can be explained by the difference in the number of studies and individuals included in each; our analysis includes a larger number of studies and individuals, which explains our estimate's higher precision. It's worth noting that prehypertension and hypertension have nearly identical prevalence rates (6). This indicates that two-thirds of adult Nigerians have high blood pressure and are at a high risk of acquiring end-stage cardiovascular events such as stroke, coronary heart disease, and chronic kidney disease.

The two measures of heterogeneity, I^2 and tau^2, show different behaviors in this study's analysis of heterogeneity. The former is known to be sensitive to study size, i.e., if the included studies are quite large, the sampling error will be near to zero, and the I2 ratio will approach 100%. (79). The minimal sample size required to measure the prehypertension prevalence of 34% found in this study with a precision of 0.05 and a 95% confidence interval was 345. (10). The papers included in this meta-analysis are relatively large, according to the selection criteria, with an interquartile range of 635 for sample sizes. As a result, even if the between-study heterogeneity is not significant, I^2 may be closer to 100 percent. This is most likely the case because a metaregression with a single predictor (the region where the study was conducted) reduced tau^2 by 35% while leaving I^2 unchanged (Figure 9).

Prehypertension is more common in Nigeria than in the United States (80) and Canada (81), equivalent to what was discovered in China (82), Iran (83), and Nepal (84) and lower than in Ghana (85), India (86), and England (81). (Figure 14).

The findings of this study, a higher prevalence of prehypertension in males than females (39.1% vs. 28.5%), are consistent with a global trend identified in another meta-analysis of published research from around the world (5). Males had a greater prevalence rate of prehypertesion in Nepal (31.6% vs 20.0%) (84), India (47.3% vs 35.1%) (86), England (53.5% vs 35%), Canada (32.9% vs 21.6%), and the United Kingdom (32.9% vs 21.6%).

In Nigeria, the higher incidence of prehypertension in urban settlements (32% vs. 37%) contrasts with findings from a nationwide study conducted in 2017, which revealed a higher prevalence of prehypertension in rural regions (37.5% vs. 24.7%) (70). The survey's findings are credible under this meta-analytic paradigm, given the overlapping confidence ranges of the pooled prevalence in rural and urban areas (24-39% and 30-44%, respectively). This high prevalence in rural regions may be a result of Nigerian rural areas' urbanization, with the adoption of lifestyles causing an increase in non-communicable diseases (70). Prehypertension was found to be more common in rural regions than in urban areas in Nepal (40.4% vs 29.3%) (23) and India (41.3% vs 40.2%). (86).

The three geopolitical regions in the country with the highest prevalence of prehypertension, in descending order, were the North-West (43%), the South-South (36%), and the South-West (33%), with the North-East having the lowest prevalence rate among the six (18%). Only the prevalence estimates in the South-West and North-East had a limited confidence interval, while the estimates in the remaining regions had wide confidence intervals (Figure 12). The South-Western and South-Southern regions' high rankings are identical to the national poll described above (70).

Conclusion

Prehypertension affects 34% of adult Nigerians (95% confidence interval: 30% -40%), or 41.4 million people. Males had a 39.1% (95% CI: 30.9-47.6%) higher prevalence of prehypertension than females, who had a frequency of 28.5% (95% CI: 21.2-36.4%). The North-East has the lowest prevalence of prehypertension, at 18%. The North-West, with a prevalence of 43%, had the highest rate of prehypertension. Rural areas had a pooled prevalence rate of 32%, whereas urban settlements had a combined prevalence of 37%. There were no statistically significant differences between the sexes or between rural and urban communities. Differences between geopolitical regions, on the other hand, were statistically significant. In conclusion, Nigeria has a significant prevalence of prehypertension, which poses a future risk of hypertension and other cardiovascular problems.

References

1. Whelton, P.K., Carey, R.M., Aronow, W.S., Casey, D.E., Collins, K.J., Hilmmelfarb C.D., et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension 2018;71:e13–115.

2. National High Blood Pressure Education Program. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment

of High Blood Pressure. Bethesda (MD): National Heart, Lung, and Blood Institute (US); 2004. Report No. 04-5230. Available from: http://www.ncbi.nlm.nih.gov/books/NBK9630/.
3. Vasan, R.S., Larson, M.G., Leip, E.P., Kannel, W.B., Levy, D. Assessment of frequency of progression to hypertension in non-hypertensive participants in the Framingham Heart Study: A cohort study. Lancet 2001;358(9294):1682–6.
4. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in blood pressure from 1975 to 2015: A pooled analysis of 1479 population-based measurement studies with 19·1 million participants. Lancet 2017;389(10064):37–55.
5. Guo, X., Zhang, X., Hu, J., Sun, Y., Zheng, L., Zou, L., et al. The prevalence and heterogeneity of prehypertension: A meta-analysis and meta-regression of published literature worldwide. Cardiovasc J Afr 2012;23(1):44–50.
6. Adeloye, D., Owolabi, E.O., Ojji, D.B., Auta, A., Dewan, M.T., Olanrewaju, T.O., et al. Prevalence, awareness, treatment, and control of hypertension in Nigeria in 1995 and 2020: A systematic analysis of current evidence. J Clin Hypertens 2021;23(5):963–977.
7. Udo, K.R., Ajayi, J.F.A., Kirk-Greene, A.H.M., Falola, T.O. Nigeria. Encyclopedia Britannica. 2020 [Accessed on 2021, July 5th]; Available from: https://www.britannica.com/place/Nigeria.
8. UNFPA - United Nations Population Fund. UNFPA - United Nations Population Fund. 2021 [Accessed on 2021, July 5th]. Available from: https://www.unfpa.org/.
9. Joanna Briggs Institute. Joanna Briggs Institute Critical Appraisal Checklist for Prevalence Studies. Joanna Briggs Institute; 2017. Available from: https://jbi.global/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Prevalence_Studies2017_0.pdf.
10. EPITOOLS. Epitools - Sample size to estimate a proportion or apparent prevalence with specified precision. [Accessed on 2021, July 28th]. Available from: https://epitools.ausvet.com.au/oneproportion.
11. R Core Team. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2021 [Accessed on 2021, June 16th]. Available from: https://www.r-project.org/.
12. Viechtbauer, W. Conducting meta-analyses in with the metafor package. J Stat Soft 2010;36(3):1–48. Available from: https://doi.org/10.18637/jss.v036.i03.
13. Sidik, K., Jonkman, J.N. On Constructing Confidence Intervals for a Standardized Mean Difference in Meta-analysis. Communications in Statistics - Simulation and Computation. 2003;32(4):1191–1203.
14. Viechtbauer, W., Cheung, M.W.-L. Outlier and influence diagnostics for meta-analysis. Res Synth Methods 2010;1(2):112–125.
15. Balduzzi, S., Rücker, G., Schwarzer, G. How to perform a meta-analysis with R: A practical tutorial. Evidence-Based Mental Health 2019;22:153–160.
16. Borenstein, M., Higgins, J.P.T., Hedges, L.V., Rothstein, H.R. Basics of meta-analysis: I^2 is not an absolute measure of heterogeneity: I^2 is not an absolute measure of heterogeneity. Res Synth Methods 2017;8(1):5–18.
17. Egger, M., Davey Smith, G., Schneider, M., Minder, C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997;315:629-634.
18. Isezuo, S.A., Sabir, A.A., Ohwovorilole, A.E., Fasanmade, O.A. Prevalence, associated factors and relationship between prehypertension and hypertension: A study of two ethnic African populations in Northern Nigeria. J Human Hypertens 2011;25:224-230.
19. Okafor, C.I., Fasanmade, O., Ofoegbu, E., Ohwovoriole, A.E. Comparison of the performance of two measures of central adiposity among apparently healthy Nigerians using the receiver operating characteristic analysis. Indian J Endocrinol Metab 2011;15(4):320–6.
20. Wokoma, F.S., Alasia, D.D. Blood Pressure Pattern in Barako-A Rural Community in Rivers State, Nigeria. Niger Health J 2011;11(1):8–13.
21. Andy, J.J., Peters, E.J., Ekrikpo, U.E., Akpan, N.A., Unadike, B.C., Ekott, .JU. Prevalence and correlates of hypertension among the Ibibio/Annangs, Efiks and Obolos: A cross sectional community survey in rural South-South Nigeria. Ethn Dis 2012;22(3):335–9. Available from: https://www.ethndis.org/edonline/index.php/ethndis/article/view/459.
22. Nwazor, F.O.O., Oputa, S.C. Blood Pressure Pattern Among Young People In South-Eastern Nigeria: A Cross-Sectional Survey. Ebonyi Med J 2012;11(1-2):77–83.
23. Adejumo, E.N., Ogundahunsi, O.A., Adejumo, O.A., Daniel, O.J., Okafor, P.A., Azenabor, A. Generalized And Abdominal Obesity; The Association With Hypertension Among Men In Ikeja, Lagos State. Niger J Clin Med 2013;5(1).
24. Charles-Davies, M.A., Fasanmade, A.A., Olaniyi, J.A., Oyewole, O.E., Owolabi, M.O., Adebusuyi, J.R., et al. Metabolic Alterations in Different Stages of Hypertension in an Apparently Healthy Nigerian Population. Int J Hypertens 2013;2013:351357.
25. Makusidi, M.A., Liman, H.M., Yakubu, A., Isah, M.D.A., Jega, R.M., Adamu, H., et al. Prevalence of Non-communicable Diseases and its Awareness among Inhabitants of Sokoto Metropolis: Outcome of

a Screening Program for Hypertension, Obesity, Diabetes Mellitus and Overt proteinuria. Arab J Nephrol Transplant 2013;6(3):189–91.
26. Okpechi, I.G., Chukwuonye, I.I., Tiffin, N., Madukwe, O.O., Onyeonoro, U.U., Umeizudike, T.I., 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(9):e73403.
27. Suleiman, I.A., Amogu, E.O., Ganiyu, K.A. Prevalence and control of hypertension in a Niger Delta semi urban community, Nigeria. Pharmacy Practice 2013;11(1):24–9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3780508/.
28. Abah, I. Hypertension prevalence, knowledge, attitude & awareness among pharmacists in Jos, Nigeria. West Afr J Pharmacy 2014;25(2):98–106.
29. Abu-Saeed, K., Odili, V.U., Muslim, J.O. High Prevalence of Hypertension among Residents of Ilorin. J Sci Pract Pharmacy 2014;1(1):54–8. Available from: http://www.jsppharm.org/home/abstract.php?id=11&aTitle=High%20Prevalence%20of%20Hypertension%20among%20Residents%20of%20Ilorin.
30. Adamu, H., Makusidi, A.M., Liman, H.M., Isah, M.D., Jega, M.R., Chijioke, A. Prevalence of Obesity, Diabetes Type 2 and Hypertension among a Sampled Population from Sokoto Metropolis-Nigeria. J Advances Med Med Res 2014;4(10):2065–80.
31. Ale, O., Ajuluchukwu, J., Oke, D., Mbakwem, A. Impact of prehypertension on left ventricular mass and QT dispersion in adult black Nigerians. Cardiovasc J Afr 2014;25(2):78–82.
32. Ganiyu, K., Kpokiri, E., Omoshue, O. Prevalence of Undiagnosed Elevated Blood Pressure in Okparabe Community in Southern Nigeria. J Sci Pract Pharm 2014;1(1):59-62.
33. Okafor, C.N., Young, E.E., Nwobi, E.A., Ike, S.O. Cardiovascular risk factors in a population of rural women in south-east Nigeria. Afr J Med Med Sci 2014;43(Suppl 1):225–32.
34. Egbuonu, A.C.C., Egbuonu, O.N.C., Akabogu, N., Udensi, Z.I., Ugwo, U.O., Ejidike, A.G. The Prevalence And Demographic Pattern Of Obesity And Its Correlates In Undergraduates Of Michael Okpara University Of Agriculture Umudike South-East, Nigeria. J Environ Toxicol Public Health 2015;1(1):11-17.
35. Egbi, O.G., Rotifa, S., Jumbo, J. Prevalence of hypertension and its correlates among employees of a tertiary hospital in Yenagoa, Nigeria. Anna Afr Med 2015;14(1):8-17.
36. Guwatudde, D., Nankya-Mutyoba, J., Kalyesubula, R., Laurence, C., Adebamowo, C., Ajayi, I., et al. The burden of hypertension in sub-Saharan Africa: A four-country cross sectional study. BMC Public Health. 2015;15(1):1211.
37. Okwuonu, C.G., Ngoka, S.C., Chimezie, O.J., Eze, T.H., Uwanurochi, K., Mbanaso, A.U. Towards prevention of hypertension in Nigeria: A study of prehypertension and its associations among apparently healthy adults in Umuahia, South-East Nigeria. Int J Prev Med 2015;6:61.
38. Oladoyinbo, C.A., Ekerette, N.N., Ogunubi, T.I. Obesity and Hypertension amongst Traders in Ijebu Ode, Nigeria. Afr J Biomed Res 2015;18(1):23–7.
39. Tagurum, Y.O., Okoh, O.E., Inalegwu, E., Ozoilo, J.U., Banwat, M.E., Zoakah, A.I. Non-communicable diseases: Prevalence and Risk Factors among Adults in a Rural Community in Plateau State, Nigeria.Int J Biomed Res 2015;6(4):228-234. Available from: http://irepos.unijos.edu.ng/jspui/handle/123456789/1083.
40. . Uwah, A., Idongesit, N., Uka, E. Prevalence of hypertension among adults attending Faith-based Centres in Abak Township, Akwa Ibom State, Nigeria. Merit Res J Med Med Sci 2015;3)7):245–8.
41. Adeoye, A.M., Adebiyi, A., Owolabi, M.O., Lackland, D.T., Ogedegbe, G., Tayo, B.O. Gender disparity in blood pressure levels among Nigerian health workers. J Clin Hypertens 2016;18(7):685–9.
42. Ajayi, I., Sowemimo, I., Akpa, O., Ossai, N. Prevalence of hypertension and associated factors among residents of Ibadan-North Local Government Area of Nigeria. Niger J Cardiol 2016;13(1):67-75.
43. Ayanniyi, O., Akinremi, A., Odunnaiya, N., Adenaike, I. Cardiovascular disease risk among professionals: A survey of modifiable risk factors among teachers in an urban community. Highland Med Res J 2016;16(1):1–6.
44. Kooffreh, M.E., Abasiodiong, M.G. Differences in Blood Pressure Levels and Its Association with Obesity Indices among Traders in Watt Market Calabar, Cross River State Nigeria. Sch Acad Biosci 2016;4(7):565–70.
45. Mmom, F.C., Chuemere, A.N. A Study of Incidence and Prevalence of Hypertension, Diabetes and Obesity with Blood Type in Postmenopausal Females in Port Harcourt. Saudi J Biomed Res 2016;1(1):22–9.
46. Olamoyegun, M., Iwuala, S., Asaolu, S., Oluyombo, R. Epidemiology and patterns of hypertension in semi-urban communities, south-western Nigeria. Cardiovasc J Afr 2016;27(6):356–60.
47. Ononamadu, C.J., Ezekwesili, C.N., Onyeukwu, O.F., Umeoguaju, U.F., Ezeigwe, O.C., Ihegboro, G.O. Comparative analysis of anthropometric indices of obesity as correlates and potential predictors of risk

for hypertension and prehypertension in a population in Nigeria. Cardiovasc J Afr 2017;28(2):92–9.
48. Aladeniyi, I., Adeniyi, O., Owolabi, E., Fawole, O., Adeolu, M., Ter Goon, D., et al. Prevalence, Awareness and Correlates of Hypertension Among Urban Public Workers in Ondo State, Nigeria. Online J Health Allied Sci 2017;16(3):1-6.
49. Ayodele, O.E., Akanbi, O.O., Akinwusi, P.O., Hassan, A.O., Ogunro, P.O. Urinary Abnormalities, Blood Pressure and Anthropometric Profiles Among Students in a Nigerian University. Trop J Nephrol 2009;4(1):21–9. Available from: http://www.tjn-online.com/index.php/tjn/article/view/91.
50. Ejike, C.E.C.C., Ukegbu, P.O. Not a 'Straitjacket Affair': Anthropometrically Derived Obesity Index Correlates of Elevated Blood Pressure among University Undergraduates. Med Sci 2017;5(2):9.
51. Nwatu, C.B., Young, E.E., Okwara, C.C., Okoli, C.E., Obi, P.C., Anyim, O.B., et al. Concurrent Prediabetes and Prehypertension in a Rural Community in South East Nigeria. J Advances Medicine Medical Res 2017;22(3):1–10.
52. Ambakederemo, T.E., Chikezie, E.U. Assessment of some traditional cardiovascular risk factors in medical doctors in Southern Nigeria. Vasc Health Risk Manag 2018;14:299–309.
53. Bello-Ovosi, B.O., Asuke, S., Abdulrahman, S.O., Ibrahim, M.S., Ovosi, J.O/, Ogunsina. M.A., et al. Prevalence and correlates of hypertension and diabetes mellitus in an urban community in North-Western Nigeria. Pan Afr Med J 2018;29(1):1–7.
54. Dokunmu, T.M., Yakubu, O.F., Adebayo, A.H., Olasehinde, G.I., Chinedu, S.N. Cardiovascular Risk Factors in a Suburban Community in Nigeria. Int J Hypertens 2018;2018:e6898527.
55. Egbi, O., Ogoina, D., Oyeyemi, A. Prevalence of hypertension and associated factors in a rural community in Bayelsa State. Int J Res Med Sci 2018;6:1106-1113.
56. Ibuaku, C., Nwajei, A., Queen, A. Anthropometric Assessment of Nutritional Status of Adults in a Non-Conflict Environment of the Niger-Delta Region of Nigeria. Int Res J Pharm Med Sci 2018;1(5):46–9.
57. Nkechi, O.I. Prevalence and Predictors of Overweight, Obesity and Hypertension among Undergraduates of a Southern Nigerian University. J Med Sci Clin Res 2018;6(12):1-9.
58. Ofori, S.N., Fobil, J.N., Odia, O.J. Household biomass fuel use, blood pressure and carotid intima media thickness; a cross sectional study of rural dwelling women in Southern Nigeria. Environ Pollut 2018;242(Pt A):390–7.
59. Olatona, F.A., Onabanjo, O.O., Ugbaja, R.N., Nnoaham, K.E., Adelekan, D.A. Dietary habits and metabolic risk factors for non-communicable diseases in a university undergraduate population. J Health Popul Nutr 2018;37(1):21.
60. Shittu, R.O., Odeigah, L.O., Fakorede, K.O., Sikiru, B.A., Sule, A.G., Musah, Y., et al. Prevalence and correlates of hypertension-outcome of a free medical screening in Oke-Ogun area of Oyo state, Nigeria, West Africa. J Am Soc Hypertens 2018;12(4):268–74.
61. Wordu, G., Akusu, O.M. Dietary Pattern and Prevalence of High Blood Pressure among Adult Traders in Port Harcourt, Nigeria. Asian J Med Health 2018;11(1):1–7.
62. Adelowo A, Mercy O. An Assessment of the Prevalence of Diabetes Mellitus and Its Risk Factors among People Living in Abuja, Nigeria. J Int Council Health Physical Educ Recreat Sport Dance 2019;5(1):171–86.
63. Adenrele, H., Mercy, O., Adelowo, A. Cardio-metabolic risk assessment among corporate workforce in Abuja. Nigeria. J Res Contemporary Issues in Human Kinetics Health Educ 2020;4(1):27–41. Available from: https://www.researchgate.net/publication/347389567_JOURNAL_OF_RESEARCH_AND_CONTEMPORARY_ISSUES_IN_HUMAN_KINETICS_AND_HEALTH_EDUCATION_PEER-REVIEWED_JORCIHKHE_2018_4_1_27_-41_CARDIO-METABOLIC_RISK_ASSESSMENT_AMONG_CORPORATE_WORKFORCE_IN_ABUJA_NIGERIA_J.
64. Ajayi, D.D., Deji, S.A., Odu, O.O., Dada, S.A., Amu, E.O., Marcus, O. Cardiovascular Disease Risk Factors Assessment of Women Attending a Religious Program in Ado Ekiti, Nigeria. Am J Biomed Life Sci 2019;7(2):36-41.
65. Obiebi, I.P., Aiwuyo, H.O. 2017 American College of Cardiology/American Heart Association Clinical Guideline-based Prevalence of Hypertension in a semi-urban community in Nigeria: Public Health Perspective. Revista Colombiana de Cardiología 2019;26(6):346–53.
66. Okubadejo, N.U., Ozoh, O.B., Ojo, O.O., Akinkugbe, A.O., Odeniyi, I.A., Adegoke, O., et al. Prevalence of hypertension and blood pressure profile amongst urban-dwelling adults in Nigeria: A comparative analysis based on recent guideline recommendations. Clin Hypertens 2019;25:7.
67. Yakubu, I.M., Bigelow, P. Prevalence and Determinants of Overweight, Obesity, Prehypertension, and Hypertension in the Banking Industry in Nigeria: An Analysis of a Nationwide Dataset. Texila Int J Pub Health 2019;7(4):1-13.
68. Banigbe, B.F., Itanyi, I.U., Ofili, E.O., Ogidi, A.G., Patel, D., Ezeanolue, E.E. High prevalence of

undiagnosed hypertension among men in North Central Nigeria: Results from the Healthy Beginning Initiative. PLoS One 2020;15(11):e0242870.
69. Dada, I.O., Igbe, I.A. Feeding habits, Overweight, Obesity and Hypertension and Associated Factors among Polytechnic Students in Ekiti State, Southwest Nigeria. J Multidisciplinary Res Healthcare. 2020;7(1):33–48.
70. Odili, A.N., Chori, B.S., Danladi, B., Nwakile, P.C., Okoye, I.C., Abdullahi, U., et al. Prevalence, Awareness, Treatment and Control of Hypertension in Nigeria: Data from a Nationwide Survey 2017. Glob Heart 2020; 15(1):47.
71. Odunaiya, N., Okoye, E., Adegoke, O., Ojoye, D., Ooguntibeju, O. High Prevalence and Clustering Of Modifiable Cardiovascular Disease Risk Factors among Nurses in Nigeria: Implication for Translating Knowledge into Practice among Health Care Professionals. Int J Pub Health Safe 2020;5(6):1–7.
72. Olaitan, O.O., Olanrewaju, O.I., Akinmoladun, F.O., Fadupin, G. Central Obesity and Stress-Predisposing Factors to Hypertension among Health Workers in Jos University Teaching Hospital, Plateau State, Nigeria. Cur Res Diabetes Obesity J 2020;12(4):111-116.
73. Olawade, D., Afolalu, T., Wada, O., Barka, I. Evaluations of Hypertension among Adult Residents of Tinda Rural Community, Nigeria. Int J Pub Health Epidemiol Res 2020;6(2):157–62.
74. Raimi, T., Odusan, O. Association of hypertension with generalized obesity in rural south-western Nigeria. J Surg Med 2020;4(3):177–81.
75. . Umuerri, E.M., Aiwuyo, H.O. Prevalence and correlates of prehypertension and hypertension among adults in Delta State, Nigeria: A cross-sectional community-based study. Ghana Med J 2020;54(1):48–57.
76. Upla, P.U., Sani, B., Hadi, N.S., Anbalaga, G.A., Anura, F., Bassey, M.I., et al. Prevalence Of Hypertension Among Residents Of Alakio Community, Lafia East Development Area, Nasarawa State. Int J Innovative Res Advanced Studies 2020;7(4):177-181.
77. Wada, O.Z., Olawade, D.B., Afolalu, T.D., Oluwatofarati, A.O., Akinwalere, I.G. Prevalence of Hypertension among Rural Adults and Availability of Management Services in Abimbola Community, Ayedaade Local Government Area, Osun State, Nigeria. J Hypertens Manag 2020;6(1):046.
78. Opreh, O.P., Olajubu, T.O., Akarakiri, K.J., Ligenza, V., Amos, J.T., Adeyeye, A.V., et al. Prevalence and factors associated with hypertension among rural community dwellers in a local government area, South West Nigeria. Afr Health Sci 2021;21(1):75–81.
79. Harrer, M., Cuijpers, P., Furukawa, T.A., Ebert, D.D. Doing Meta-Analysis with R: A Hands-On Guide. Chapman and Hall Book, CRC Group, 2021. Available from: https://www.routledge.com/Doing-Meta-Analysis-with-R-A-Hands-On-Guide/Harrer-Cuijpers-Furukawa-Ebert/p/book/9780367610074.
80. Booth, J.N., Li, J., Zhang, L., Chen, L., Muntner, P., Egan, B. Trends in Prehypertension and Hypertension Risk Factors in US Adults. Hypertension 2017;70(2):275–84.
81. Joffres, M., Falaschetti, E., Gillespie, C., Robitaille, C., Loustalot, F., Poulter, N., et al. Hypertension prevalence, awareness, treatment and control in national surveys from England, the USA and Canada, and correlation with stroke and ischaemic heart disease mortality: A cross-sectional study. BMJ Open 2013 ;3(8):e003423.
82. Jin, N., Li, G., Li, H., Chen, L., Leng, B. [Incidence and risk factors of prehypertension among adults in mainland China: a meta-analysis]. Nan fang yi ke da xue xue bao(J Southern Med Uni) 2013;33(12):1738–43.
83. Afsargharehbagh, R., Rezaie-Keikhaie, K., Rafiemanesh, H., Balouchi, A., Bouya, S., Dehghan, B. Hypertension and Pre-Hypertension Among Iranian Adults Population: A Meta-Analysis of Prevalence, Awareness, Treatment, and Control. Curr Hypertens Rep 2019;21(4):27.
84. Huang, Y., Guo, P., Karmacharya, B.M., Seeruttun, S.R., Xu, D.R., Hao, Y. Prevalence of hypertension and prehypertension in Nepal: A systematic review and meta-analysis. Glob Health Res Policy 2019;4(1):11.
85. Dosoo, D.K., Nyame, S., Enuameh, Y., Ayetey, H., Danwonno, H., Twumasi, M., et al. Prevalence of Hypertension in the Middle Belt of Ghana: A Community-Based Screening Study. Int J Hypertens 2019;2019:e1089578.
86. Tripathy, J.P., Thakur, J.S., Jeet, G., Chawla, S., Jain, S. Alarmingly high prevalence of hypertension and pre-hypertension in North India-results from a large cross-sectional STEPS survey. PLoS One 2017;12(12):e0188619.