


# Prevalence of hypertensive disorders of pregnancy and pregnancy outcomes in Sub-Saharan Africa: A systematic review and meta-analysis

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## Abstract

Hypertensive disorders of pregnancy are one of the leading causes of poor pregnancy outcomes and are associated with increased rates of maternal mortality, preterm birth, small for gestational age newborns, stillbirth, and neonatal death. The overall and type-specific prevalence of hypertensive disorders of pregnancy and associated pregnancy outcomes are unknown in Sub-Saharan Africa. Therefore, this review aimed to identify the prevalence of hypertensive disorders of pregnancy and associated pregnancy outcomes in Sub-Saharan Africa. A systematic review and meta-analysis were conducted on observational facility-based studies irrespective of publication status, sample size, language, and follow-up duration from 19 countries between the years 2000 and 2018 in Sub-Saharan Africa. A review of studies using PubMed, EMBASE, African Index Medicus, and African Journals Online was completed with independent extraction of studies by review authors using the predefined inclusion criteria. Quality and risk of bias of individual studies were assessed using the Joanna Briggs Institute Checklist. Random effects model was used to estimate the pooled prevalence of hypertensive disorders of pregnancy and type-specific hypertensive disorders of pregnancy. A pooled adjusted odds ratio with 95% confidence interval for each study was calculated using comprehensive meta-analysis version 2 software to estimate the association of hypertensive disorders of pregnancy and its outcomes. The existence of heterogeneity was assessed using  $I^2$  and its corresponding P value. We assessed the presence of publication bias using the Egger's test. Subgroup analysis was performed to assess the potential effect of variables, and a sensitivity analysis was conducted to assess any undue influence from studies. The analysis included 70 studies. The pooled prevalence of hypertensive disorders of pregnancy (all types combined), chronic hypertension, gestational hypertension, preeclampsia, and eclampsia were 8% (95% confidence interval = [5, 10]), 0.9% (95% confidence interval = [0.4, 1.8]), 4.1% (95% confidence interval = [2.4, 7]), 4.1% (95% confidence interval = [3.2, 5.1]), and 1.5% (95% confidence interval = [1, 2]), respectively. Compared with normotensive pregnant or postpartum women, women with hypertensive disorders of pregnancy were associated with increased risk of maternal mortality, odds ratio = 17 (95% confidence interval = [9.6, 28.8]); cesarean section, odds ratio = 3.1 (95% confidence interval = [1.7, 5.6]); perinatal mortality, odds ratio = 8.2 (95% confidence interval = [2.8, 24]); low birth weight, odds ratio = 3.2 (95% confidence interval = [2, 5]); and preterm delivery, odds ratio = 7.8 (95% confidence interval = [2.5, 25.3]) according to this analysis. The pooled prevalence of hypertensive disorders of pregnancy was high in Sub-Saharan Africa compared to those reported from other regions. Pregnant or postpartum women with hypertensive disorders of pregnancy have increased risk of maternal mortality, cesarean section, preterm delivery, perinatal mortality, and low birth weight newborn. Therefore, creating awareness of the risks of hypertensive disorders

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of pregnancy is essential. Pregnant women with hypertensive disorders need due attention to manage appropriately and more importantly to have favorable outcomes in this population.

## Keywords

hypertensive disorders of pregnancy, pregnancy outcomes, prevalence, Sub-Saharan Africa

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## Background

Globally, over the past 25 years, the maternal mortality ratio (MMR) has decreased by almost 44%, from 385 maternal deaths per 100,000 live births in 1990 to an estimated 216 maternal deaths per 100,000 live births in 2015.<sup>1</sup> Approximately 99% of the global maternal deaths in 2015 are from low- and middle-income countries (LMICs), with Sub-Saharan Africa (SSA) alone accounting for roughly 66%.<sup>2</sup> In many regions of the world, maternal mortality has declined, but it has increased in 50 countries and 27 of which are in SSA.<sup>3</sup> According to a recent report from the World Health Organization (WHO), in some African settings, hypertensive disorders of pregnancy (HDP) are the leading cause of maternal mortality.<sup>4</sup> HDP are multisystem disorders, which include gestational hypertension, chronic hypertension, superimposed preeclampsia on chronic hypertension, and preeclampsia.<sup>5,6</sup> They contribute to 14% and 16% maternal mortality worldwide and in SSA, respectively.<sup>7</sup>

In addition, HDP also contribute to adverse fetal outcomes.<sup>8</sup> HDP increase the risk of preterm birth, stillbirth, small for gestational age, and neonatal death,<sup>9</sup> and expose the mother to an emergency cesarean section, which increases the risk of low birth weight infants and neonatal death.<sup>10</sup>

Globally, 2.73% of women suffer from HDP while the incidence of chronic hypertension, preeclampsia, and eclampsia are 0.29%, 2.16% and 0.28%, respectively.<sup>11</sup> However, in Africa, a relatively higher prevalence of HDP is reported, as it affects 1 in 10 women.<sup>12</sup> Furthermore, there is concern that recent reports on the global burden of HDP underrepresent SSA populations, indicating the importance of further research addressing HDP among this population.<sup>13</sup> The burden of hypertension has been increasing over the past few decades in SSA; however, a large percentage of the population with hypertension remains untreated, ineffectively treated, or even undiagnosed, contributing to the growing cardiovascular disorder problem in this region.<sup>14</sup>

Little is known about the prevalence of HDP in SSA despite widespread investigation in high-income countries.<sup>4</sup> Hence, to the best of our awareness, we conducted the first systematic review and meta-analysis to estimate the overall and type-specific prevalence of HDP and associated pregnancy outcomes in SSA, to educate policymakers and guide strategies for early detection, prevention, and management of these disorders in the region. Therefore,

the aim of this systematic review and meta-analysis was to determine the prevalence of HDP in SSA and investigate associated adverse pregnancy outcomes.

## Methods

### *Eligibility criteria*

Any observational facility-based study conducted to determine prevalence and/or adverse pregnancy outcomes of any type of HDP in SSA from 2000 to 2018 was included.

All observational studies (cohort and cross-sectional) were included regardless of publication status, sample size, language, or follow-up duration. The inclusion criteria comprised of the following: (1) facility-based studies; (2) sampling of a defined population or studies involving entire populations; (3) involving pregnant or postpartum participants; (4) reporting on the prevalence of chronic hypertension, superimposed preeclampsia, gestational hypertension, preeclampsia, and/or eclampsia and/or their pregnancy outcomes in a population of pregnant or postpartum women residing in SSA countries; and (5) defined HDP as blood pressure greater than 140/90 mmHg<sup>15</sup> or urine protein and elevated blood pressure above 140/90 mmHg. Studies that did not meet the inclusion criteria were excluded. Longitudinal studies where prevalence of HDP or pregnancy outcomes were not determined were also excluded. In addition, case-control studies from pooled prevalence of HDP were also excluded from the analysis to minimize bias.

### *Information sources and search*

A literature search was undertaken using the databases PUBMED and EMBASE. Studies were also retrieved by searches of African Index Medicus and the African Journals Online (AJOL) using all possible key subject headings. In addition to searching databases, supplementary approaches to identifying studies such as hand-searching of journals, checking reference lists, searching websites, and contacting authors were performed. MeSH and free text terms were used to increase sensitivity to potentially appropriate studies. When MeSH terms were not used (websites), search terms were recognized, and all possible substitutes and spellings were found and used in the search strategy.

The following search terms were used: prevalence, proportion, magnitude, epidemiology, hyperten\$, “chronic hypertension,” hypertension, blood pressure, “high blood pressure,” preeclampsia, preeclampsia-eclampsia, pre-eclampsia-eclampsia, pre-eclampsia, eclampsia, preeclampsia superimposed, pre-eclampsia superimposed, superimposed preeclampsia, superimposed pre-eclampsia, pregnancy induced hyperten\$, hypertension, pregnancy induced, hyperten\$ disorders of pregnancy, hypertensive disorders in pregnancy, gestational hyperten\$, gestational hypertension, hyperten\$ gestational, pregnancy outcome, outcome of pregnancy, maternal mortality, maternal death, death of mother, perinatal mortality, perinatal death, still-birth, small for gestational age, low birth weight, cesarean section, cesarean birth, prematurity, premature birth, preterm, preterm delivery, preterm labor, preterm birth, and Sub-Saharan Africa.

The search strategy for each database is available in Tables S1 and S2. The reference list of all relevant review papers was scrutinized to identify other potential data sources. The search, which was performed and overseen by two review authors (K.S.G. and N.A.), was restricted to studies in humans published between January 2000 and November 2018. Specific search terms, inclusion and exclusion criteria, searched databases, and eventual data needed to be collected and reported were considered during searching. The review authors collaborated, and consensus was needed throughout the process, with continued discussions on steps of searching during the review.

### Study selection

Eligibility assessment of selected studies was performed independently by two authors (K.S.G. and N.A.) in two phases. First, titles and abstracts of retrieved literature were reviewed to check for eligibility for the second phase, which consists of full-text screening. During this phase, the authors further screened for eligibility to include in the study. Disagreements between the two reviewers were resolved by consensus and/or resolved through discussion with the third review author (B.M.).

### Data collection process

First review author (K.S.G.) extracted the data from the eligible studies, which was then kept on a data extraction sheet and checked by the second review author (N.A.). Disagreements were resolved by the discussion between the two review authors, otherwise the third review author (B.M.) decided. The studies were checked for duplication based on name of authors, sample size, outcomes, and study location. Data on year of study, country of study, study design, type of HDP, sample size, blood pressure measurement, definition(s) used for HDP, and prevalence of HDP were extracted.

All citations identified by electronic databases and manual searches were organized, duplicates deleted, and each citation assigned a unique identification number. All extracted data were stored in a Microsoft Excel file format. PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines were used for all procedures and reporting.<sup>16</sup>

### Data items

The participants were pregnant or postpartum women (population) with HDP (condition) in SSA (context). Pregnant or postpartum women (population) who are diagnosed with HDP (exposure) and normotensive pregnant or postpartum women (control) were seen for associated adverse pregnancy outcomes (outcome) in SSA.

The prevalence of HDP is the primary outcome of this study. The classification of HDP includes chronic hypertension, gestational hypertension, preeclampsia—de novo or superimposed on chronic hypertension and white coat hypertension.<sup>17–19</sup> Hypertension in pregnancy is defined as a systolic blood pressure (SBP) of 140 mmHg or more and/or diastolic blood pressure (DBP) of 90 mmHg or more on two or more consecutive occasions during pregnancy.<sup>18</sup> Gestational hypertension is an elevation of SBP greater than or equal to 140 mmHg and DBP greater than or equal to 90 mmHg without proteinuria in a previously normotensive non-proteinuria pregnant woman after 20 weeks of pregnancy.<sup>18,19</sup>

Preeclampsia is defined as women who develop both hypertension and proteinuria in pregnancy after 20 weeks of gestation.<sup>18</sup> In this review, any forms of preeclampsia were included as preeclampsia (i.e. severe preeclampsia, mild preeclampsia, and superimposed preeclampsia). Eclampsia is the occurrence of convulsions or fit with SBP of >140 mmHg and DBP of >90 mmHg after 20 weeks of gestation, proteinuria of >2+, and signs and symptoms of severe preeclampsia.<sup>20,21</sup> Chronic hypertension is defined as high blood pressure predating the pregnancy or recognized at less than 20 weeks of gestation.<sup>22</sup>

Preeclampsia superimposed on chronic hypertension refers to a sudden increase in blood pressure and new onset of proteinuria in women with hypertension and no proteinuria in early pregnancy (less than 20 weeks of gestation).<sup>23</sup>

The HDP definition was either reported by authors, in which case we depend on it; or we pooled data from eligible studies reporting on at least three of the four entities of HDP (i.e. chronic hypertension, gestational hypertension, preeclampsia/eclampsia, and superimposed preeclampsia/eclampsia) to acquire a rough approximation of the general prevalence of overall HDP in SSA, as limited studies reported an overall prevalence of HDP (four combined entities).<sup>12</sup> Specific HDP in this review was each type of HDP-like chronic hypertension, gestational hypertension, preeclampsia, or eclampsia.

The secondary outcomes of this analysis include maternal mortality, cesarean section, perinatal mortality, preterm delivery, and low birth weight. Maternal mortality is defined as

the death of a pregnant woman or death within 42 days of termination of pregnancy, irrespective of site and the duration of the pregnancy, from any cause related to or intensified by the pregnancy or its management but not from unintentional or incidental causes.<sup>24</sup>

Cesarean section/birth is the delivery of a baby through incisions made in the mother's abdomen and uterus.<sup>25</sup> Perinatal mortality includes stillbirths (fetal loss after 28 weeks of gestation) and neonatal deaths (during first 7 days of life).<sup>26</sup> Premature delivery is when birth occurs between 20 and 37 weeks of gestation.<sup>27</sup> Low birth weight has been defined by the WHO as birth weight less than 2500 g<sup>28</sup> with infants whose weight is less than the 10th percentile for gestational age classified as small for gestational age.<sup>29</sup>

### Quality and risk of bias assessment

Quality and risk of bias of studies were assessed using the Joanna Briggs Institute assessment based on the Critical Appraisal Checklist for Studies Reporting Prevalence Data 2017. The study evaluated the quality of all included studies in accordance with the nine criteria. The criteria have a rating scale of 0, 1, and 2.<sup>30</sup> Depending on the score achieved (from 0 to 18), studies were categorized as being high (>14), medium (11–14), or low (<11) quality.<sup>31</sup> The review authors performed an assessment of the risk of bias independently and any studies which did not fulfill minimum criteria (low quality) were excluded from the meta-analysis.

### Statistical analysis

The study used baseline data for cohort studies and the total number of pregnant women reported during a given period. Using studies which reported pregnancy outcomes, an unadjusted odds ratio (OR) with 95% confidence interval (CI) was calculated using comprehensive meta-analysis version 2 package. In addition to overall pooled prevalence for all forms of HDP, subgroup and sensitivity analysis was also performed. Considering the “synthesis of results,” the raw proportion was transformed into a suitable unit for meta-analysis using logit transformation. A random effects model was used to account for possible heterogeneity between studies, which defaults to the fixed effects model approach in the absence of heterogeneity to obtain an overall summary estimate of the prevalence across studies and pooled study-specific estimates.<sup>32</sup> The P value of less than 0.05 was considered a significant association between HDP and pregnancy outcomes. Statistical heterogeneity was evaluated with the Cochran chi-square

( $\chi^2$ ), and I<sup>2</sup> statistic<sup>33</sup> (low <25%, moderate 25%–50%, high >50%) was computed with its corresponding P value.

### Risk of bias across studies

The study assessed the possibility of publication bias using Egger's linear regression test as formal statistical test for publication bias.<sup>34</sup> A P value of less than 0.10 on the Egger's test was considered indicative of statistically significant publication bias.

### Additional analyses

Subgroup analysis was conducted by specific types of HDP, design, and regions of SSA. Furthermore, the degree to which the main findings of a review were affected by changes in the methods or in the data used from individual studies was explored by the sensitivity analysis. The sensitivity analysis was also done considering diagnostic criteria, high prevalence, and wide CI.

## Results

### Study characteristics

The literature search identified 1327 references through PubMed database and 3784 through EMBASE database (Figure 1). An additional 79 studies were found from African Index Medicus and AJOL. Following the removal of duplicates, 262 records were screened for relevance by reviewing the title and abstract. As a result, 99 full-text articles were assessed against the inclusion criteria. Consequently, 29 studies were excluded, including 9 studies which presented results differently, 6 community-based studies, 5 studies without prevalence and pregnancy outcomes of HDP, and 7 studies with no clear diagnostic criteria for HDP. Thus, 70 full-text studies remained for analysis (Table 1).

There were studies that used only DBP for diagnosis of HDP<sup>20,35–37</sup> and other studies that used DBP cutoff of 80 mmHg instead of 90 mmHg.<sup>38,39</sup> There were studies that included severe preeclampsia (DBP > 110 and proteinuria).<sup>37,40,41</sup> Some studies used international organization diagnostic criteria (e.g. European Society of Hypertension and WHO standard),<sup>42–44</sup> while eclampsia was also diagnosed based on the presence of hypertension/preeclampsia and convulsion in others.<sup>45–49</sup> Since we retained the aforementioned studies, their effect on heterogeneity of meta-analysis was seen during subgroup and sensitivity analysis.

The characteristics of the cross-sectional,<sup>1,9,35,36,40,42,46–89</sup> prospective, or retrospective cohort and longitudinal studies<sup>5,10,37–39,41,90–103</sup> included in this review from 19 Sub-Saharan African countries are summarized in Table 1. The majority of studies were conducted in Nigeria, Ethiopia, and Tanzania, which are 21, 16, and 6, respectively. The majority of studies that included in the analysis were

**Table 1.** Summary characteristics of studies on hypertensive disorders of pregnancy in Sub-Saharan Africa...

Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
Chronic hypertension <sup>10</sup>	Prospective cohort study	789	Elevated blood pressure at <20 weeks of gestation	Between July 2012 and March 2014	Ghana	2%
Chronic hypertension <sup>102</sup>	Retrospective cohort study	39,993	BP 140/90 mm Hg or above recorded before 20 weeks of gestation	From July 2000 to December 2010	Tanzania	4.8%
Chronic hypertension <sup>50</sup>	Cross-sectional study	1856	BP > 140/90 mm Hg before 20 weeks of gestation	Between 1 January and 28 February 2013	Ghana	1.2%
Chronic hypertension <sup>51</sup>	Cross-sectional study	2393	Preexisting SBP of 140 mm Hg or greater and/or DBP of 90 mm Hg	From January 1997 to December 2002	Nigeria	1%
Chronic hypertension <sup>91</sup>	Cohort study	3491	Preexisting BP of $\geq$ 140/90 mm Hg observed before 20th week of gestation	From 15 May 2005 to 2007	Nigeria	0.3%
Chronic hypertension <sup>96</sup>	Prospective cohort study	3909	SBP > 140 mm Hg and/or DBP > 90 mm Hg before 20 weeks of gestation	2000 to 2008	Tanzania	1.2%
Chronic hypertension <sup>52</sup>	Cross-sectional study	5415	SBP > 140 mm Hg and/or DBP > 90 mm Hg before 20 weeks of gestation	From 1 January 2010 to 1 December 2013	Ethiopia	0.1%
Chronic hypertension <sup>53</sup>	Cross-sectional study	25,792	SBP > 140 mm Hg or DBP > 90 mm Hg before 20 weeks of gestation	2008 to 2010	Madagascar	0.3%
Chronic hypertension <sup>39</sup>	Longitudinal study	216	BP > 140/80 mm Hg before 20 weeks of gestation	March 2011 to December 2011	Nigeria	1.3%
Chronic hypertension <sup>97</sup>	Prospective cohort study	716	SBP > 140 mm Hg or DBP > 90 mm Hg before 20 weeks of gestation	From July 2012 to March 2014	Ghana	2.2%
Chronic hypertension <sup>54</sup>	Cross-sectional study	1620	SBP > 140 mm Hg or DBP > 90 mm Hg before 20 weeks of gestation	1 October 2011 to 31 September 2012	Togo	1.2%
Chronic hypertension <sup>92</sup>	Cohort study	3247	Patients with history or diagnosed hypertension before 20 weeks of amenorrhea	From 1 July 2012 to 31 March 2013	Burkina Faso	0.7%
Chronic hypertension <sup>9</sup>	Prospective surveillance	14,170	SBP > 140 mm Hg or DBP > 90 mm Hg before 20 weeks of gestation	From August 2014 through July 2015	Botswana	4.8%
Eclampsia <sup>55</sup>	Cross-sectional study	42,963	BP > 140/90 mm Hg plus convulsion	From 1 January 2009 to 30 December 2013	Ethiopia	0.7%
Eclampsia <sup>37</sup>	Retrospective cohort study	9086	Grand mal seizure with features of preeclampsia and no history of a seizure disorder	From 1 January 2016 to 31 December 2016	Zimbabwe	0.3%
Eclampsia <sup>46</sup>	Cross-sectional study	13,682	Generalized tonic-clonic convulsion during pregnancy excluding others cause of convulsion	From 1 January 1994 to 31 December 2003	Nigeria	0.9%
Eclampsia <sup>47</sup>	Cross-sectional study	2792	Convulsions and preeclampsia	Between 1 April 2010 and 31 March 2011	Nigeria	2.2%
Eclampsia <sup>48</sup>	Cross-sectional study	4471	Proteinuria at presentation and anticonvulsants used	Between 1 May 2005 and 30 April 2008	Nigeria	1.30%

(Continued)



Table 1. (Continued)

Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
Eclampsia <sup>49</sup>	Cross-sectional study	10,163	When convulsions occur with syndrome of preeclampsia	Not identified	Nigeria	1.2%
Eclampsia <sup>56</sup>	Cross-sectional study	306	BP > 140/90 mm Hg and convulsion	From July to September 2015	Namibia	9.15%
Eclampsia <sup>57</sup>	Cross-sectional study	1863	BP > 140/90 mm Hg and convulsion	From 1 April 2009 to 31 March 2010	Ethiopia	2%
Eclampsia <sup>58</sup>	Cross-sectional study	1981	BP ≥ 140/90 mm Hg plus proteinuria and convulsion	From 1 January 2010 to 31 December 2014	Ethiopia	5.4%
Eclampsia <sup>59</sup>	Cross-sectional study	2197	ISSHP	Between 1 January 2002 and 31 December 2005	Nigeria	9.4%
Eclampsia <sup>60</sup>	Cross-sectional study	3500	BP ≥ 140/90 mm Hg plus convulsion	Between 1 May 2014 and 30 April 2015	Ethiopia	2.7%
Eclampsia <sup>61</sup>	Cross-sectional study	3952	SBP ≥ 140 mm Hg, DBP 90 mm Hg, proteinuria > 1+ and convulsions	Between 1 January 2005 to 31 December 2010	Nigeria	2.10%
Eclampsia <sup>62</sup>	Cross-sectional study	4316	ISSHP	From 1 December 2015 to 31 July 2016	Madagascar	1.5%
Eclampsia <sup>90</sup>	Follow-up study	5860	BP ≥ 140/90 mm Hg and proteinuria and seizures	From April 2012 to March 2013	South Africa	0.5%
Eclampsia <sup>63</sup>	Cross-sectional study	5868	ISSHP	Between 1 March 2000 and 28 February 2005	Nigeria	0.8%
Eclampsia <sup>64</sup>	Cross-sectional study	6598	BP > 140/90 mm Hg plus convulsion	From 2008 to 2014	Nigeria	0.8%
Eclampsia <sup>65</sup>	Cross-sectional study	13,943	SBP ≥ 140 mm Hg, DBP 90 mm Hg, proteinuria > 1+ and convulsions	Between April 2008 and May 2009	Nigeria	5%
Eclampsia <sup>103</sup>	Retrospective cohort study	15,318	Fit and > 140/90 mm Hg at least 2+ proteinuria with or without edema and convulsion	From 1 January 1995 to 31 December 2004	Nigeria	4.3%
Eclampsia <sup>66</sup>	Cross-sectional study	17,169	SBP ≥ 140 mm Hg, DBP > 90 mm Hg and convulsion	From January 2008 to December 2016	Nigeria	0.84%
Eclampsia <sup>67</sup>	Cross-sectional study	17,592	SBP > 140 mm Hg and/or DBP > 90 mm Hg and convulsion	Between 2003 and 2007	Congo	1.8%
Eclampsia <sup>68</sup>	Cross-sectional study	25,425	BP > 140/90 mm Hg plus convulsion	During 18-month period	Zimbabwe	0.6%
Eclampsia <sup>53</sup>	Cross-sectional study	25,792	SBP > 140 mm Hg and/or DBP > 90 mm Hg and convulsion	2008 to 2010	Madagascar	0.7%
Eclampsia <sup>40</sup>	Cross-sectional study	2500	Conditions not attributable to other conditions in a patient with preeclampsia	From 1 June 2012 to 31 June 2014	Cameroon	0.5%
Eclampsia <sup>69</sup>	Cross-sectional study	100	BP > 140/90 mm Hg and 4+ urine protein and convulsion	Between 3 September and 12 October 2007	Zanzibar	2%

(Continued)

**Table 1.** (Continued)

Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
Eclampsia <sup>70</sup>	Cross-sectional study	320	BP > 140/90 mm Hg and convulsion	From 8 July 2014 to 7 July 2015	Ethiopia	0.9%
Eclampsia <sup>71</sup>	Cross-sectional study	708	Signs and symptoms of severe preeclampsia and convulsions or coma	From 1 July 2018 to 10 July 2018	Ethiopia	2.3%
Eclampsia <sup>72</sup>	Cross-sectional study	1 100	BP > 140/90 mm Hg and convulsion	From November 2004 to April 2005	Cameroon	1.6%
Eclampsia <sup>101</sup>	Retrospective cohort study	2094	Standard criteria (Davey and MacGillivray, 1988; Huddle et al., 1993)	During 4-month period in 1997	South Africa	0.5%
Eclampsia <sup>73</sup>	Cross-sectional study	3398	DBP ≥ 90 mm Hg or SBP ≥ 140 mm Hg and convulsion	Between July 2011 and December 2012	Tanzania	1.6%
Eclampsia <sup>91</sup>	Cross-sectional study	3491	Generalized seizure occurred in a patient with HDP	From 15 May 2005 to 2007	Nigeria	2%
Eclampsia <sup>74</sup>	Cross-sectional study	3931	SBP ≥ 140 mm Hg, DBP 90 mm Hg, proteinuria > 1+ and convulsions	From 1 January 2003 to 31 December 2007	Nigeria	5.7%
Eclampsia <sup>75</sup>	Cross-sectional study	5562	Convulsion > 24 weeks of pregnancy with BP > 140/90 mm Hg and proteinuria	From June 2009 to February 2010	Tanzania	1.37%
Eclampsia <sup>76</sup>	Cross-sectional study	6262	BP > 140/90 mm Hg plus convulsion	From 1 January to 31 December 2009	Nigeria	0.91%
Eclampsia <sup>77</sup>	Cross-sectional study	8626	SBP > 140 mm Hg or DBP > 90 mm Hg and convulsion	From September 2011 to August 2014	Ethiopia	0.6%
Eclampsia <sup>78</sup>	Cross-sectional study	35,741	BP > 140/90 mm Hg plus convulsion	From October 1994 to September 1999	Ethiopia	0.7%
Eclampsia <sup>51</sup>	Cross-sectional study	2393	SBP of 140 mm Hg or greater and/or DBP of 90 mm Hg or greater and convulsion	From January 1997 to December 2002	Nigeria	2.8%
HDP <sup>53</sup>	Cross-sectional study	25,792	SBP > 140 mm Hg and/or DBP > 90 mm Hg	2008 to 2010	Madagascar	5.11%
HDP <sup>55</sup>	Cross-sectional study	42,963	SBP > 140 mm Hg or DBP > 90 mm Hg	2009 to 2013	Ethiopia	8.1%
HDP <sup>35</sup>	Cross-sectional study	5248	DBP 90 mm Hg or more recorded twice 4 to 6 h apart	From January 2003 to June 2003	Malawi	1.30%
HDP <sup>36</sup>	Cross-sectional study	6493	DBP > 90 mm Hg, protein excretion of 300 mg and more	From 1 March 2000 to 28 February 2005	Nigeria	11.30%
HDP <sup>79</sup>	Cross-sectional study	160	SBP > 140 mm Hg and/or DBP > 90 mm Hg	From May to June 2014	Cameroon	46%
HDP <sup>82</sup>	Cross-sectional study	289	BP ≥ 140/90 mm Hg	September 2012	Zimbabwe	21.5%
HDP <sup>70</sup>	Cross-sectional study	320	BP > 140/90 mm Hg	From 8 July 2014 to 7 July 2015	Ethiopia	8.80%

(Continued)

Table 1. (Continued)

Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
HDP <sup>71</sup>	Cross-sectional study	708	SBP $\geq$ 140 mm Hg and/or DBP $\geq$ 90 mm Hg	From 1 July 2018 to 10 July 2018	Ethiopia	9.9%
HDP <sup>50</sup>	Cross-sectional study	1856	SBP $>$ 140 mm Hg and/or DBP $>$ 90 mm Hg	Between 1 January and 28 February 2013	Ghana	19.8%
HDP <sup>57</sup>	Cross-sectional study	1863	SBP $>$ 140 mm Hg or DBP $>$ 90 mm Hg	From 1 April 2009 to 31 March 2010	Ethiopia	8.48%
HDP <sup>92</sup>	Cohort study	3247	Based on European Society of Hypertension	From 1 July 2012 to 31 March 2013	Burkina Faso	9.60%
HDP <sup>95</sup>	Longitudinal study	3424	SBP $>$ 140 mm Hg or DBP $>$ 90 mm Hg	For 1 year	Ethiopia	5.3%
HDP <sup>91</sup>	Cross-sectional study	3491	BP $\geq$ 140 mm Hg (systolic)/90 mm Hg (diastolic) on at least two readings	From 15 May 2005 to 2007	Nigeria	6.2%
HDP <sup>52</sup>	Cross-sectional study	5415	BP at least 140 mm Hg for systolic and/or 90 mm Hg for diastolic on at least two occasions	From 1 January 2010 to 1 December 2013	Ethiopia	2.4%
HDP <sup>90</sup>	Cross-sectional study	5860	BP $\geq$ 140/90 mm Hg	From April 2012 to March 2013	South Africa	12.5%
HDP <sup>9</sup>	Prospective surveillance	14,170	At least one SBP $>$ 140 mm Hg or DBP $>$ 90 mm Hg	From August 2014 through July 2015	Botswana	22.20%
HDP <sup>77</sup>	Cross-sectional study	8626	SBP $>$ 140 mm Hg or DBP $>$ 90 mm Hg	From September 2011 to August 2014	Ethiopia	3.90%
HDP <sup>10</sup>	Prospective cohort study	789	SBP $\geq$ 140 mm Hg and/or DBP $\geq$ 90 mm Hg on two separate occasions	Between July 2012 and March 2014	Ghana	11.3%
HDP <sup>102</sup>	Retrospective cohort study	39,993	SBP 140 mm Hg or more and DBP 90 mm Hg or above	From July 2000 to December 2010	Tanzania	4.8%
HDP <sup>38</sup>	Retrospective cohort study	249,771	SBP of or above 140 mm Hg or DBP of or above 90 mm Hg	Between February 2006 and December 2012	Zambia	2.1%
HDP <sup>39</sup>	Longitudinal study	216	BP $>$ 140/80 mm Hg	From March to December 2011	Nigeria	17%
HDP <sup>5</sup>	Retrospective cohort study	30,750	SBP $>$ 140 mm Hg or DBP $>$ 90 mm Hg	From 2008 to 2013	Ethiopia	3.6%
HDP <sup>69</sup>	Cross-sectional study	100	Equal to or greater than 140/90 mm Hg blood pressure	Between 3 September and 12 October 2007	Zanzibar	2%
HDP <sup>97</sup>	Prospective cohort study	759	SBP $>$ 140 mm Hg or DBP $>$ 90 mm Hg	From July 2012 to March 2014	Ghana	9.9%
HDP <sup>80</sup>	Cross-sectional study	910	SBP at least 140 mm Hg or DBP at least 90 mm Hg	From August 2011 through May 2012	Tanzania	6.90%
HDP <sup>54</sup>	Cross-sectional study	1620	BP $\geq$ 140/90 mm Hg	From 1 October 2011 to 31 September 2012	Togo	12.3%
HDP <sup>101</sup>	Retrospective cohort study	2094	Standard criteria (Davey and MacGillivray, 1988; Huddle et al., 1993)	During 4-month period in 1997	South Africa	18.2%

(Continued)



Table 1. (Continued)

Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
HDP <sup>51</sup>	Cross-sectional study	2393	SBP of 140 mmHg or greater and/or DBP of 90 mm Hg or greater on at least two readings	Between January 1997 and December 2002	Nigeria	5.30%
HDP <sup>60</sup>	Prospective study	3168	SBP > 140 mmHg and/or DBP > 90 mmHg	From October 2011 to July 2012	Sudan	2.17%
HDP <sup>96</sup>	Prospective cohort study	3909	BP 140 mm Hg SBP or more and DBP 90 mm Hg or above	Between 2000 and 2008	Tanzania	5.2%
HDP <sup>48</sup>	Cross-sectional study	4471	SBP > 140 mm Hg or DBP > 90 mm Hg	Between 1 May 2005 and 30 April 2008	Nigeria	1%
HDP <sup>81</sup>	Cross-sectional study	7702	BP > 140/90, proteinuria > I +, with or without edema	From January 2009 to December 2012	Ethiopia	2.6%
GH <sup>93</sup>	Cohort study	180	BP > 140/90 mm Hg measured on two separate occasions after 20 weeks of gestation	2015	Nigeria	6.7%
GH <sup>82</sup>	Cross-sectional study	289	BP ≥ 140/90 mm Hg begins after 20 weeks of gestation, and resolves by the 6th week postpartum	From 2009 to 2011	Zimbabwe	19.4%
GH <sup>99</sup>	Prospective longitudinal study	416	BP ≥ 140/90 mm Hg on two occasions after 20 weeks of gestation	2009	Mauritius	13.5%
GH <sup>71</sup>	Cross-sectional study	708	De novo hypertension arising after mid-pregnancy without proteinuria	From 1 July 2018 to 10 July 2018	Ethiopia	9.9%
GH <sup>97</sup>	Prospective cohort study	759	BP > 140/90 mm Hg after 20 weeks of gestation on two separate occasions	2012 to 2014	Ghana	7.8%
GH <sup>98</sup>	Prospective cohort study	2630	DBP of 90 mm Hg or higher or SBP of 140 mm Hg or higher	Between July 2006 and February 2009	Nigeria	28.9%
GH <sup>83</sup>	Cross-sectional study	16,985	SBP > 140 mm Hg and/or DBP > 90 mm Hg	From July 2010 to June 2012	Ethiopia	0.5%
GH <sup>10</sup>	Prospective cohort study	789	SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg on two separate occasions without proteinuria after 20 weeks of gestation	Between July 2012 and March 2014	Ghana	7.5%
GH <sup>53</sup>	Cross-sectional study	25,792	SBP > 140 mm Hg and/or DBP > 90 mm Hg	2008 to 2010	Madagascar	3.3%
GH <sup>39</sup>	Longitudinal study	216	BP > 140/80 mm Hg	From March to December 2011	Nigeria	9.7%
GH <sup>69</sup>	Cross-sectional study	100	BP > 140/90 mm Hg	Between 3 September and 12 October 2007	Zanzibar	9%
GH <sup>93</sup>	Prospective study	178	BP higher than 140/90 mm Hg	Not specified	Nigeria	6.7%
GH <sup>70</sup>	Cross-sectional study	320	BP ≥ 140/90 mm Hg	From 8 July 2014 to 7 July 2015	Ethiopia	1.3%
GH <sup>54</sup>	Cross-sectional study	1620	SBP > 140 mm Hg and/or DBP > 90 mm Hg	From 1 October 2011 to 31 September 2012	Togo	4.1%
GH <sup>57</sup>	Cross-sectional study	1863	DBP of 90 mm Hg or higher or SBP of 140 mm Hg or higher	From 1 April 2009 to 31 March 2010	Ethiopia	0.4%

(Continued)

Table 1. (Continued)

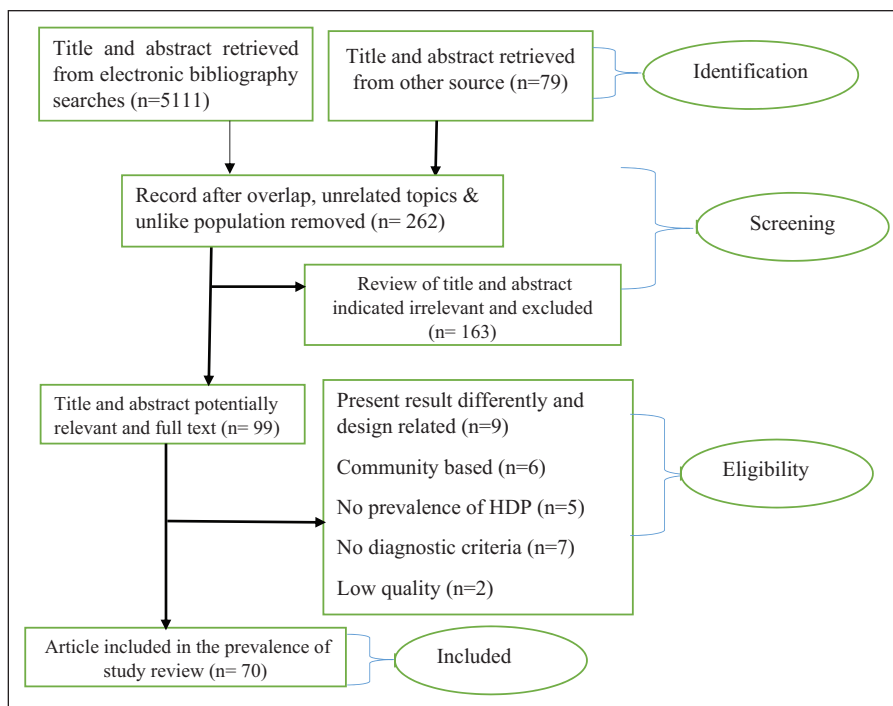
Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
GH <sup>51</sup>	Cross-sectional study	2393	SBP of 140 mm Hg or greater and/or DBP of 90 mm Hg or greater on at least two readings	From January 1997 to December 2002	Nigeria	1.3%
GH <sup>92</sup>	Cohort study	3247	SBP > 140 mm Hg and/or DBP > 90 mm Hg	From 1 July 2012 to 31 March 2013	Burkina Faso	0.8%
GH <sup>91</sup>	Cohort study	3491	De novo hypertension did not show any features of preeclampsia	From 15 May 2005 to 2007	Nigeria	3.4%
GH <sup>96</sup>	Prospective cohort study	3909	SBP > 140 mm Hg and/or DBP > 90 mm Hg	2000 to 2008	Tanzania	0.5%
GH <sup>80</sup>	Cross-sectional study	5860	BP ≥ 140/90 mm Hg	From April 2012 to March 2013	South Africa	6.7%
Preeclampsia <sup>102</sup>	Retrospective cohort study	39,993	BP 140/90 mm Hg or above with proteinuria	From July 2000 to December 2010	Tanzania	4.1%
Preeclampsia <sup>37</sup>	Retrospective cohort study	9086	DBP > 110 mm Hg and proteinuria	From 1 January 2016 to 31 December 2016	Zimbabwe	1%
Preeclampsia <sup>40</sup>	Cross-sectional study	2500	BP ≥ 160/110 mm Hg and proteinuria	From 1 June 2012 to 31 June 2014	Cameroon	4.44%
Preeclampsia <sup>41</sup>	Retrospective cohort study	2337	DBP ≥ 110 mm Hg or SBP ≥ 160 mm Hg or urine protein ≥ 5 g/24h	From 1 January 2005 to 31 December 2008	Nigeria	3.30%
Preeclampsia <sup>42</sup>	Cross-sectional study	11,585	Standard criteria (Davey and MacGillivray, modified by the ISSHP)	2002 to 2003	South Africa	11.5%
Preeclampsia <sup>84</sup>	Cross-sectional study	574	SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg and proteinuria	From 1 July 2011 to 28 February 2012	Ethiopia	0.7%
Preeclampsia <sup>85</sup>	Cross-sectional study	422	SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg and proteinuria	From 10 January to 9 February 2016	Ethiopia	18.25%
Preeclampsia <sup>71</sup>	Cross-sectional study	708	SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg and proteinuria	From 1 July 2018 to 10 July 2018	Ethiopia	6.5%
Preeclampsia <sup>86</sup>	Cross-sectional study	1667	ISSHP	From November 2005 to June 2006	Mali	7.8%
Preeclampsia <sup>50</sup>	Cross-sectional study	1856	SBP of at least 140 mm Hg and/or a DBP of at least 90 mm Hg and proteinuria	Between 1 January and 28 February 2013	Ghana	7.5%
Preeclampsia <sup>58</sup>	Cross-sectional study	1981	BP ≥ 140/90 mm Hg plus proteinuria	From 1 January 2010 to 31 December 2014	Ethiopia	10.50%
Preeclampsia <sup>92</sup>	Cohort study	3247	DBP of 90 mm Hg or higher, or SBP of 140 mm Hg or higher and proteinuria	From 1 July 2012 to 31 March 2013	Burkina Faso	1.9%
Preeclampsia <sup>73</sup>	Cross-sectional study	3398	DBP ≥ 90 mm Hg or SBP ≥ 140 mm Hg with proteinuria	Between July 2011 and December 2012	Tanzania	0.8%
Preeclampsia <sup>96</sup>	Prospective cohort study	3909	BP 140/90 mm Hg or above recorded after 20 weeks of gestation age combined with proteinuria	2000 to 2008	Tanzania	3.5%
Preeclampsia <sup>62</sup>	Cross-sectional study	4316	ISSHP	From 1 December 2015 to 31 July 2016	Madagascar	1.9%

(Continued)

**Table 1.** (Continued)

Type	Study design	Sample size	Diagnosis	Study period	Country	Prevalence
Preeclampsia <sup>90</sup>	Cohort study	5860	BP $\geq$ 140/90 mm Hg and proteinuria after the 20th week of pregnancy	From April 2012 to March 2013	South Africa	1.4%
Preeclampsia <sup>81</sup>	Cross-sectional study	7702	BP > 140/90 mm Hg proteinuria > I +, with or without edema	From January 2009 to December 2012	Ethiopia	2.23%
Preeclampsia <sup>87</sup>	Cross-sectional study	8524	BP > 140/90 mm Hg and proteinuria	From 2009 to 2011	Nigeria	1.20%
Preeclampsia <sup>94</sup>	Longitudinal prospective analytical survey	11,784	BP 140/90 mm Hg or higher with proteinuria	From 1 January 1996 to 31 December 2003	Ghana	7.03%
Preeclampsia <sup>67</sup>	Cross-sectional study	17,592	SBP > 140 mm Hg and/or DBP > 90 mm Hg and proteinuria	Between 2003 and 2007	Congo	8.5%
Preeclampsia <sup>10</sup>	Prospective cohort study	789	SBP $\geq$ 140 mm Hg and/or DBP $\geq$ 90 mm Hg on two separate occasions with proteinuria after 20 weeks of gestation	Between July 2012 and March 2014	Ghana	1.8%
Preeclampsia <sup>53</sup>	Cross-sectional study	25,792	SBP > 140 mm Hg and/or DBP > 90 mm Hg and proteinuria	2008 to 2010	Madagascar	1.6%
Preeclampsia <sup>88</sup>	Cross-sectional study	33,832	SBP > 140 mm Hg and/or DBP > 90 mm Hg and proteinuria	From April 1992 to March 1997	South Africa	7.1%
Preeclampsia <sup>55</sup>	Cross-sectional study	42,963	BP $\geq$ 140/90 mm Hg plus proteinuria	From 1 January 2009 to 30 December 2013	Ethiopia	3.5%
Preeclampsia <sup>39</sup>	Longitudinal study	216	BP > 140/80 mm Hg and proteinuria	From March 2011 to December 2011	Nigeria	4.6%
Preeclampsia <sup>69</sup>	Cross-sectional study	100	BP > 140/90 mm Hg and 4+ urine protein	Between 3 September and 12 October 2007	Zanzibar	9%
Preeclampsia <sup>93</sup>	Cohort study	180	BP > 140/90 measured twice after 20 weeks of gestation plus proteinuria	2015	Nigeria	7.3%
Preeclampsia <sup>70</sup>	Cross-sectional study	320	SBP $\geq$ 140 mm Hg; DBP > 90 mm Hg; proteinuria > I +	From 8 July 2014 to 7 July 2015	Ethiopia	6.6%
Preeclampsia <sup>99</sup>	Prospective longitudinal study	416	SBP $\geq$ 140 mm Hg and/or DBP $\geq$ 90 mm Hg and albumin $\geq$ I +	2004	Mauritius	8.2%
Preeclampsia <sup>89</sup>	Cross-sectional study	490	SBP $\geq$ 140 mm Hg and/or DBP $\geq$ 90 mm Hg and proteinuria	Between August and September 2013	Ethiopia	8.40%
Preeclampsia <sup>72</sup>	Cross-sectional study	1100	BP > 140/90 mm Hg with proteinuria	From November 2004 through April 2005	Cameroon	7.7%
Preeclampsia <sup>57</sup>	Cross-sectional study	1863	BP > 140/90 mm Hg with proteinuria	From 1 April 2009 to 31 March 2010	Ethiopia	5%
Preeclampsia <sup>77</sup>	Cross-sectional study	8626	BP > 140/90 mm Hg and proteinuria	From November 2014 to March 2014	Ethiopia	2.1%

BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure; ISSHP: International Society for the Study of Hypertension in Pregnancy; HDP: hypertensive disorders of pregnancy; GH: gestational hypertension.



**Figure 1.** Summary of literature search for prevalence of hypertensive disorders of pregnancy in Sub-Saharan Africa.

completed within 3 years of study period. The sample size of the studies ranged from 100 in Zanzibar<sup>69</sup> to 249,771 in Zambia,<sup>38</sup> with a total of 780,469 participants. Overall, 29,980 (3.8%) pregnant women from a total of 780,469 study participants were recorded as suffering from disorders during antepartum and/or intrapartum period.

Many studies consisted of retrospective record review with consecutive sampling of women at various stages of pregnancy till 6 weeks postpartum. The studies have reported overall HDP (Table 1), chronic hypertension, gestational hypertension, preeclampsia,<sup>41,72,84–86,94,104</sup> and eclampsia.<sup>47,49,59,60,63,65,66,75,76,78,103,105–108</sup>

### Prevalence of HDP

The pooled prevalence of HDP (all types combined) was 8% (95% CI=[6, 10]; Figure 2). The most common forms of specific HDP were preeclampsia and gestational hypertension with a prevalence of 4.1% (95% CI=[3.2, 5.1]; Figure 3) and 4.1% (95% CI=[2.4, 7]; Figure 4), respectively. The less common types of specific HDP were chronic hypertension (0.9%; 95% CI=[0.4, 1.8]; Figure 5) and eclampsia (1.5%; 95% CI=[1.1, 2]; Figure 6). Although there was substantial heterogeneity (Table 2), no publication bias was found for overall and type-specific HDP.

### Subgroup analysis

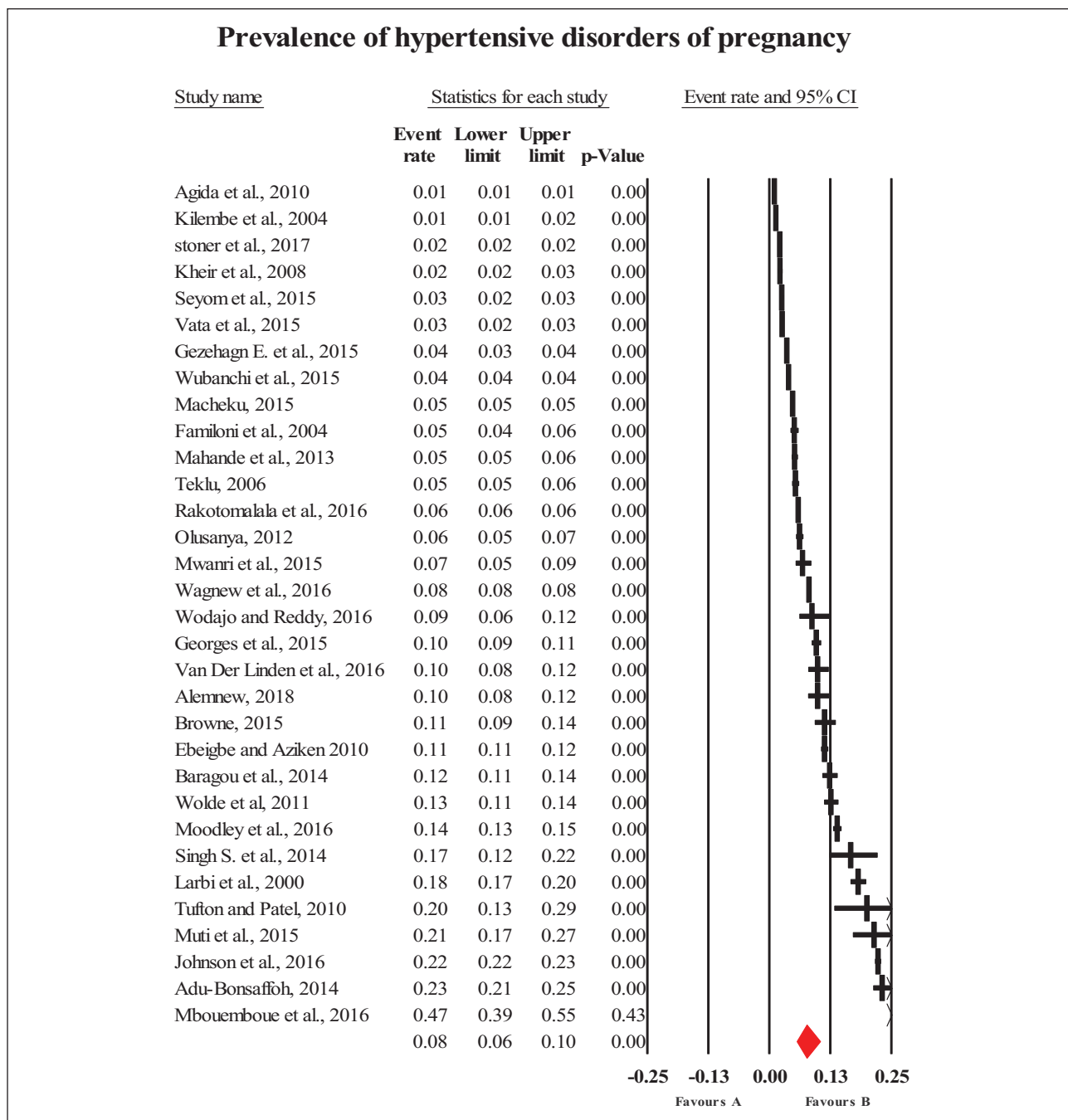
Subgroup analysis of HDP by design and region revealed substantial heterogeneity across the studies in terms of HDP prevalence ( $I^2 > 83\%$ ,  $P < 0.0001$ ). There was a

tendency for study-specific prevalence to vary by study design and region, with the cross-sectional and western SSA studies reporting significantly higher prevalence ( $P < 0.0001$ ).

Subgroup analysis of HDP prevalence by SSA region showed a significantly higher pooled prevalence in west (2%; 95% CI=[1.3, 2.9] for eclampsia) and central (6.7%; 95% CI=[3.1, 13.8] for preeclampsia) SSA. The subgroup analysis by study design also revealed high pooled prevalence in cross-sectional (3.1%, 95% CI=[2.9, 3.3] for chronic hypertension; 4.7%, 95% CI=[3.5, 6.1] for preeclampsia; and 1.6%, 95% CI=[1.2, 2.3] for eclampsia) and cohort (5.7%, 95% CI=[2.8, 11.2] for gestational hypertension) study designs. The lowest prevalence estimates were observed in eastern (0.5%, 95% CI=[0.1, 2.3] for chronic hypertension; 1.5%, 95% CI=[0.6, 3.8] for gestational hypertension; and 3.6%, 95% CI=[2.5, 5.3] for preeclampsia) and southern (1%, 95% CI=[0.5, 1.7] for eclampsia) SSA (Table 3).

The studies in the analysis included a mix of cross-sectional, prospective, or retrospective cohort and longitudinal studies; prospective and longitudinal studies reported on the prevalence of various HDP outcomes. The analyses were accomplished by consecutively omitting one study at a time to endorse the results. Sensitivity analysis was completed using diagnostic criteria, sample size, and width of CI, although change in heterogeneity was insignificant.

The meta-regression indicates that the number of publications on HDP is increasing which shows that hypertensive disorders are currently receiving attention (Figure 7). This is aligned with the current shift of attention to



**Figure 2.** Meta-analysis of prevalence of overall hypertensive disorder of pregnancy.

non-communicable diseases such as hypertension and cardiovascular disease specifically in the LMICs.

**Pregnancy outcomes of HDP**

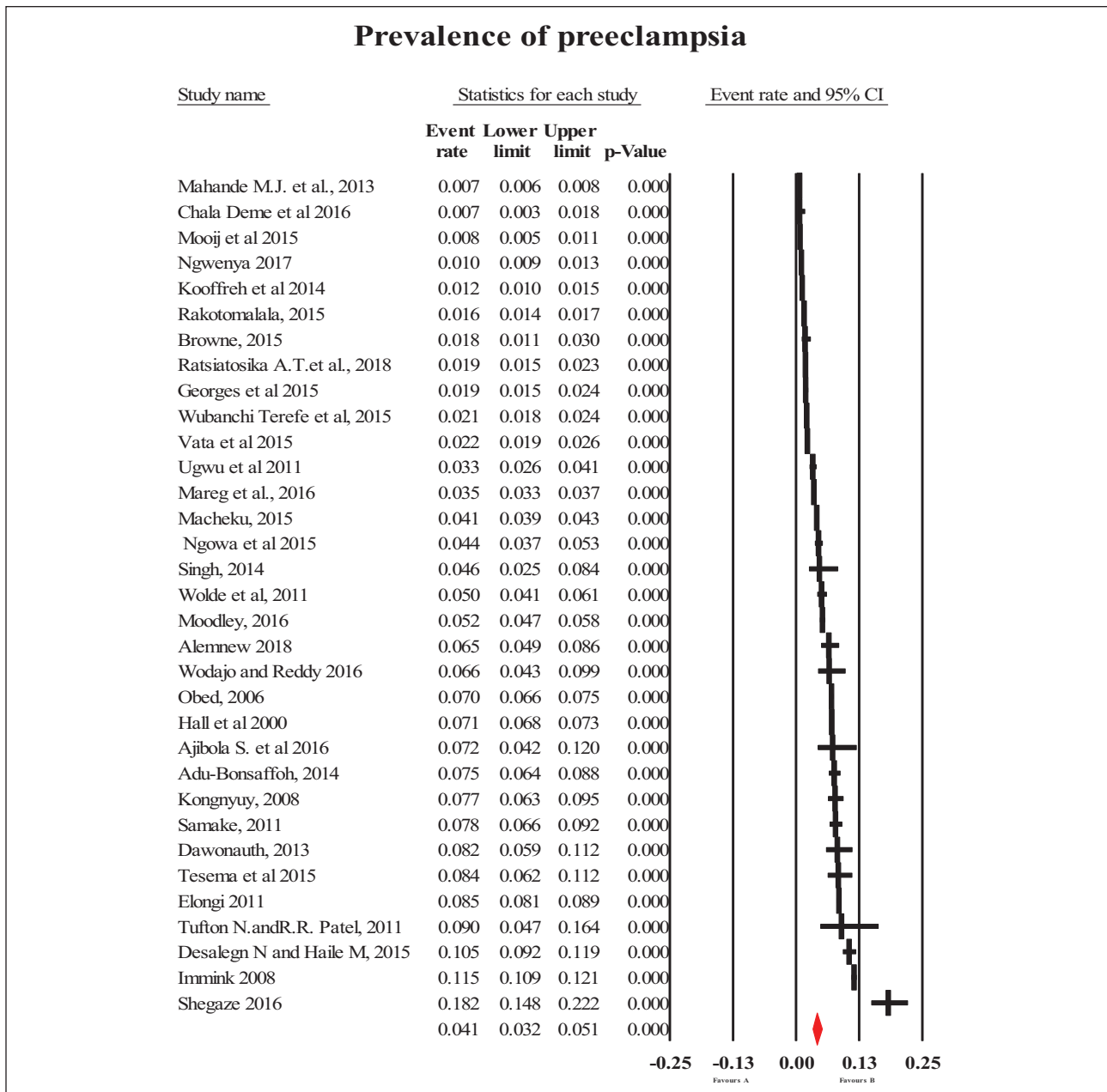
The meta-analysis shows that maternal mortality was significantly associated with HDP, OR=17 (95% CI=[9.6, 28.8]) with homogeneity among the studies’ findings,  $I^2=0.000$ ,  $P=<0.0001$ <sup>52,56,65,109–111</sup> (Figure 8).

The meta-analysis also showed pregnant women with hypertensive disorders were more likely to have cesarean

section compared to normotensive pregnant women, OR=3.1 (95% CI=[1.7, 5.6]). However, there was high heterogeneity among the studies,  $I^2=86.45%$ ,  $P=<0.0001$ <sup>44,109,110,112</sup> (Figure 9).

Perinatal mortality was significantly associated with HDP, OR=8.2 (95% CI=[2.8, 24]), although the meta-analysis revealed large heterogeneity,  $I^2=96.9%$ ,  $P=<0.0001$ <sup>44,65,82,109,112</sup> (Figure 10).

The pooled risk of having a low birth weight newborn was high among women who have HDP compared to normotensive pregnant women, OR=3.2 (95% CI=[2, 5]). However,



**Figure 3.** Meta-analysis of prevalence of preeclampsia.

the meta-analysis revealed high heterogeneity among the studies,  $I^2=57.7\%$ ,  $P=0.0001^{9,109,111}$  (Figure 11).

HDP have significant pooled association with preterm delivery,  $OR=7.8$  ( $95\% CI=[2.5, 25.3]$ ), though the meta-analysis of studies had high heterogeneity,  $I^2=84.34\%$ ,  $P=0.001^{52,113,114}$

#### Publication bias

There was no evidence of publication bias across studies reporting on the prevalence of HDP, chronic hypertension, gestational hypertension, and preeclampsia with the Egger's test for bias giving a P value of 0.27, 0.10, 0.33,

and 0.11, respectively. However, there was some indication of publication bias across studies reporting on eclampsia prevalence, with the Egger's test for bias giving a P value of 0.037 (Table 2).

Duval and Tweedie's trim and fill analysis using the random effect model analysis was performed for overall HDP, chronic hypertension, gestational hypertension, preeclampsia, and eclampsia. The adjusted values were zero to the right or left of the mean for overall HDP, gestational hypertension, and preeclampsia, and 2 to the left of the mean and 4 to the right of the mean for chronic hypertension and eclampsia, respectively, although insignificant.



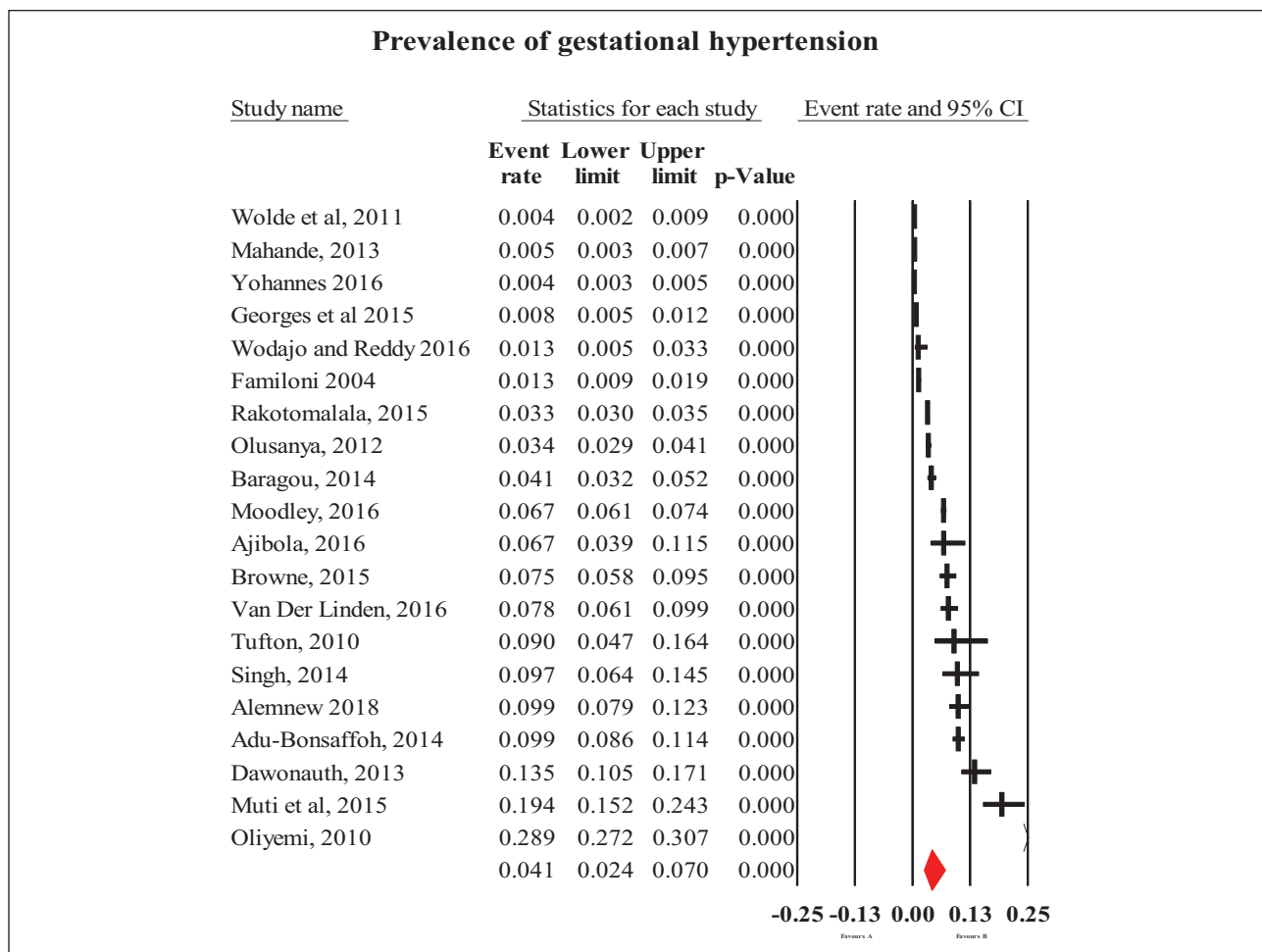


Figure 4. Meta-analysis of prevalence of gestational hypertension.

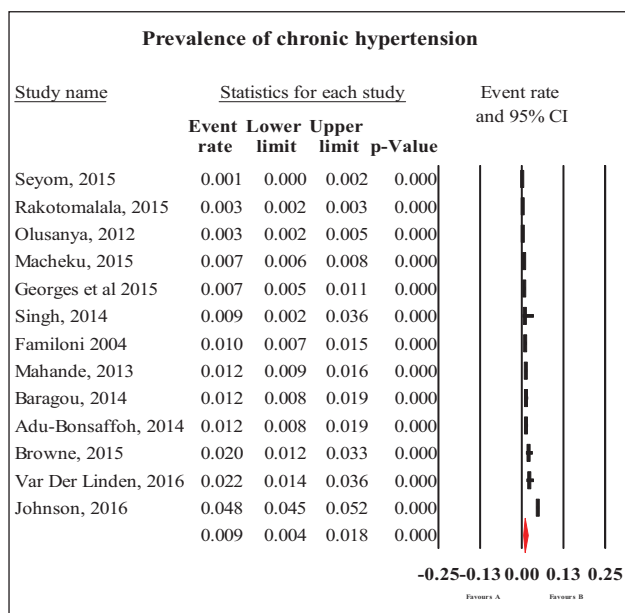
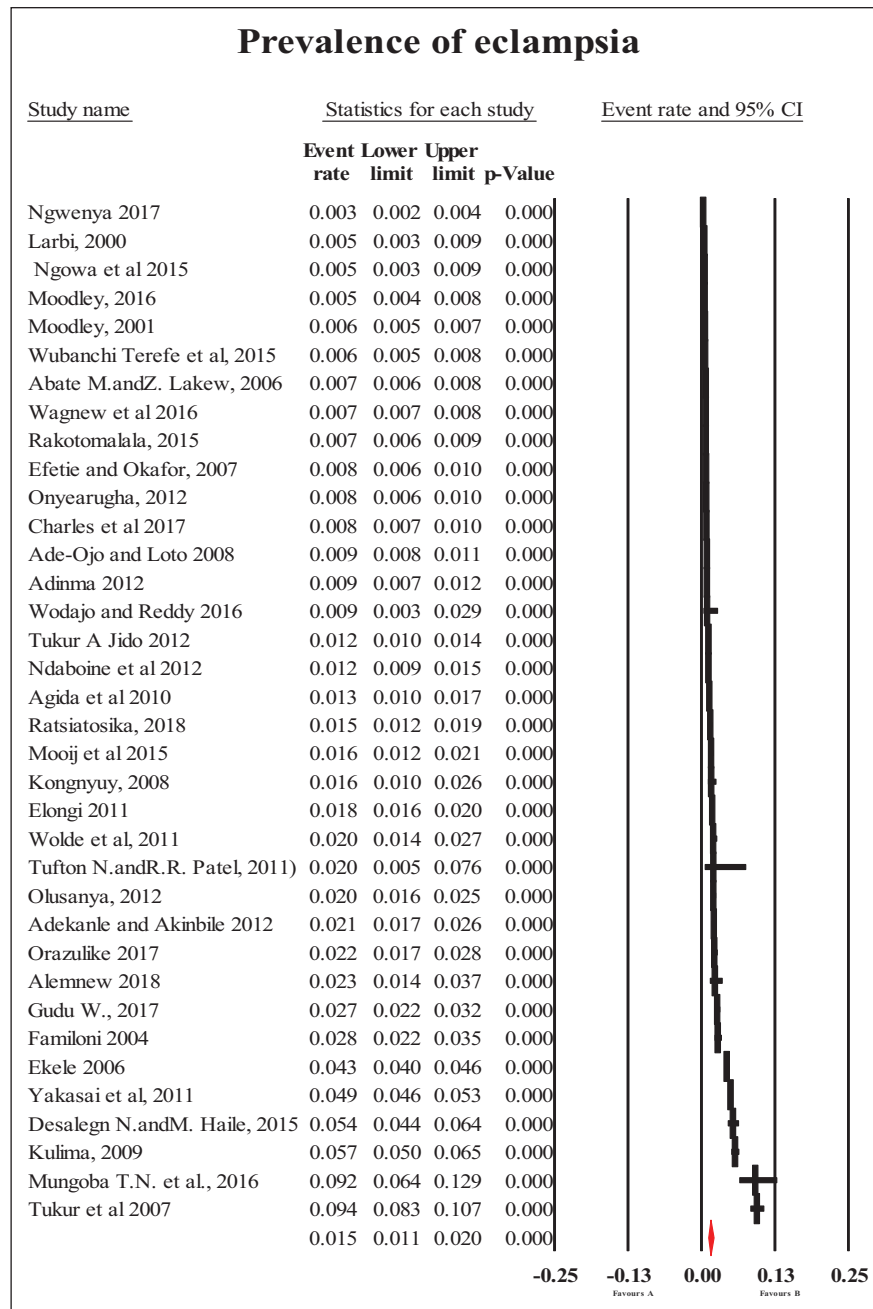


Figure 5. Meta-analysis of prevalence of chronic hypertension.

## Discussion

This meta-analysis confirms that HDP are associated with adverse pregnancy outcomes. Maternal and fetal complications increase with HDP; however, appropriate maternal and perinatal care can prevent adverse outcomes such as eclampsia, maternal and perinatal death.

The overall prevalence of HDP was 8% in SSA which is in line with global estimates (5.2%–8.2%),<sup>13</sup> slightly lower than a review from Africa (10%),<sup>12</sup> and higher than the pooled prevalence of HDP in Ethiopia (6.1%).<sup>115</sup> This may be due to sample size differences, inclusion criteria, and vast geographical differences. The finding is also higher than the global secondary analysis of the WHO’s multi-country survey prevalence of 2.7%.<sup>11</sup> The difference might be due to variability in maternal risk factors, socio-demographic factors, and the difference in prenatal care service utilization. Most studies were facility-based from the record review, which may result in inflated numbers. Due to poor health-seeking behavior, women typically present late and with advanced disease states in SSA that contributed to high maternal and perinatal morbidity and mortality.<sup>7,12,116</sup>



**Figure 6.** Meta-analysis of prevalence of eclampsia.

**Table 2.** Summary statistics of the prevalence of hypertensive disorders of pregnancy in Sub-Saharan Africa.

	Prevalence [95% confidence interval]	Number of studies	Number of participants	I <sup>2</sup>	P value of heterogeneity	P value of Egger's test
Overall HDP	8 [5, 10]	32	478,570	99.8	<0.0001	0.27
Chronic hypertension	0.9 [0.4, 1.8]	13	103,607	99.1	<0.0001	0.10
Gestational hypertension	4.1 [2.4, 7]	20	73,421	99.4	<0.0001	0.33
Preeclampsia	4.1 [3.2, 5.1]	33	271,630	99.2	<0.0001	0.11
Eclampsia	1.5 [1, 2]	36	311,063	99.0	<0.001	0.035

I<sup>2</sup>: heterogeneity; HDP: hypertensive disorders of pregnancy.

**Table 3.** Subgroup analysis of prevalence of hypertensive disorders of pregnancy by study design and regions in Sub-Saharan Africa.

Subgroup	Number of studies	Prevalence [95% CI]	Test of heterogeneity (I <sup>2</sup> )	P value
CH by design				
Cohort study	6	0.8 [0.7, 0.9]	89.1	<0.0001
Cross-sectional study	7	3.1 [2.9, 3.3]	99.2	<0.0001
CH by region of SSA				
East SSA	3	0.5 [0.1, 2.3]	94.1	<0.0001
South SSA	2	1.2 [0.2, 7.5]	99.8	<0.0001
West SSA	7	1 [0.4, 2.9]	83.7	<0.0001
Eclampsia by design				
Cohort study	4	0.8 [0.3–2]	99.1	<0.0001
Cross-sectional study	32	1.6 [1.2–2.3]	98.9	<0.0001
Eclampsia by region				
Central SSA	3	1.2 [0.5–3]	89.9	<0.0001
East SSA	10	1.5 [0.9–2.4]	98.1	<0.0001
South SSA	8	1 [0.5–1.7]	97.0	<0.0001
West SSA	15	2 [1.3–2.9]	99.0	<0.0001
GH by design				
Cohort study	9	5.7 [2.8–11.2]	99.3	<0.0001
Cross-sectional study	11	3.2 [1.7–6.1]	98.8	<0.0001
GH by region				
East SSA	6	1.5 [0.6–3.8]	98.8	<0.0001
South SSA	4	8.9 [3.0–23.6]	99.1	<0.0001
West SSA	9	5.6 [2.7–11.5]	99.3	<0.0001
Preeclampsia by design				
Cohort study	10	2.9 [1.9–4.5]	99.0	<0.0001
Cross-sectional study	23	4.7 [3.5–6.1]	99.3	<0.0001
Preeclampsia by region				
Central SSA	3	6.7 [3.1–14]	95.7	<0.0001
East SSA	13	3.6 [2.5–5.3]	98.8	<0.0001
South SSA	8	4.2 [2.6–6.7]	99.6	<0.0001
West SSA	9	3.9 [2.4–6.1]	98.2	<0.0001

CI: confidence interval; CH: chronic hypertension; SSA: Sub-Saharan Africa; GH: gestational hypertension.

Furthermore, there may be delayed and lack of intervention due to poor infrastructure. As a result, most studies had a relatively high prevalence of eclampsia that affected overall pooled analysis.

The pooled prevalence of preeclampsia was 4.1% in SSA, and this finding is in line with the prevalence of preeclampsia in Africa (5.3%),<sup>12</sup> the United States (3%–5%),<sup>117,118</sup> and global estimate (1.8%–4.4%).<sup>13</sup> The pooled prevalence of eclampsia was 1.5% according to this review, which is similar to a review performed in Africa (1.47%)<sup>12</sup> and global estimates (0.2%–9.2%),<sup>13</sup> but slightly higher than a survey performed in China (0.9%) and WHO multi-country survey prevalence of 0.3%.<sup>11</sup> The difference may be due to racial differences since this study focused on Sub-Saharan African countries.<sup>12,119–121</sup> Furthermore, the variation may be attributed to differences in ethnic background, age distribution, socioeconomic status, parity, and study methodology. The pregnant women in SSA may have presented immediately with convulsions and right away diagnosed with eclampsia and no diagnosis ever of

high blood pressure or anything. Estimates also varied substantially according to the SSA region, with a significantly higher prevalence of HDP among women in central and western SSA compared to other parts of SSA.

There was high heterogeneity between studies which showed an insignificant decrease when subgroup analysis was performed. However, the meta-analysis did not identify any other underlying causes of heterogeneity, suggesting that either populations with HDP are varied or the determination of HDP and outcomes may not be consistent. Meanwhile, it might be due to differences in geographical locations, diagnostic and measurement methods of disorders, socioeconomic status, and sample size. Hence, it also highlights the necessity to standardize HDP definition in SSA.<sup>12</sup>

The meta-analysis has shown that maternal mortality has a significant association with HDP. Mothers with hypertensive disorders were more exposed to maternal mortality and morbidities as compared to those who were not affected.<sup>51</sup> Moreover, according to the studies in 29

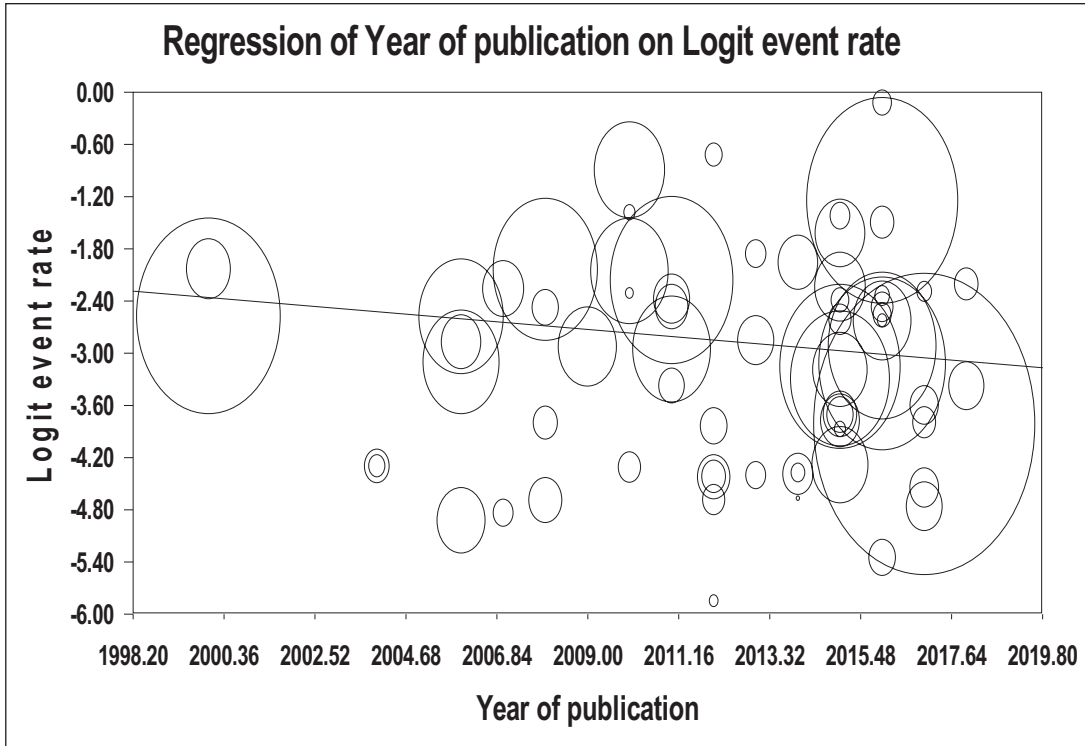


Figure 7. Meta-regression of studies on hypertensive disorders of pregnancy by year of publication in SSA.

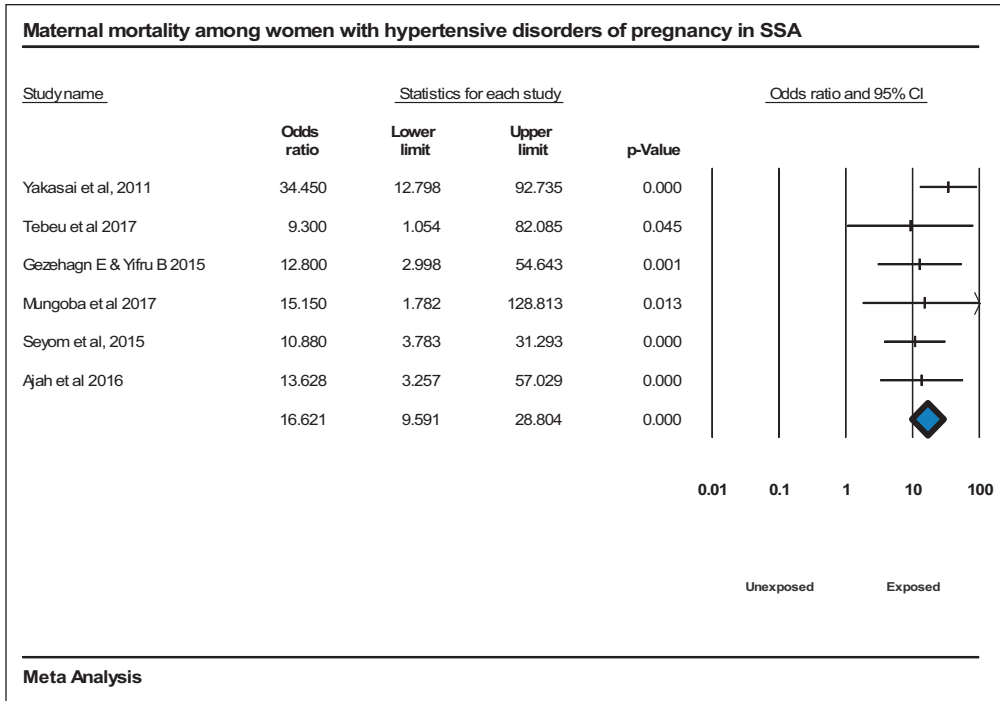
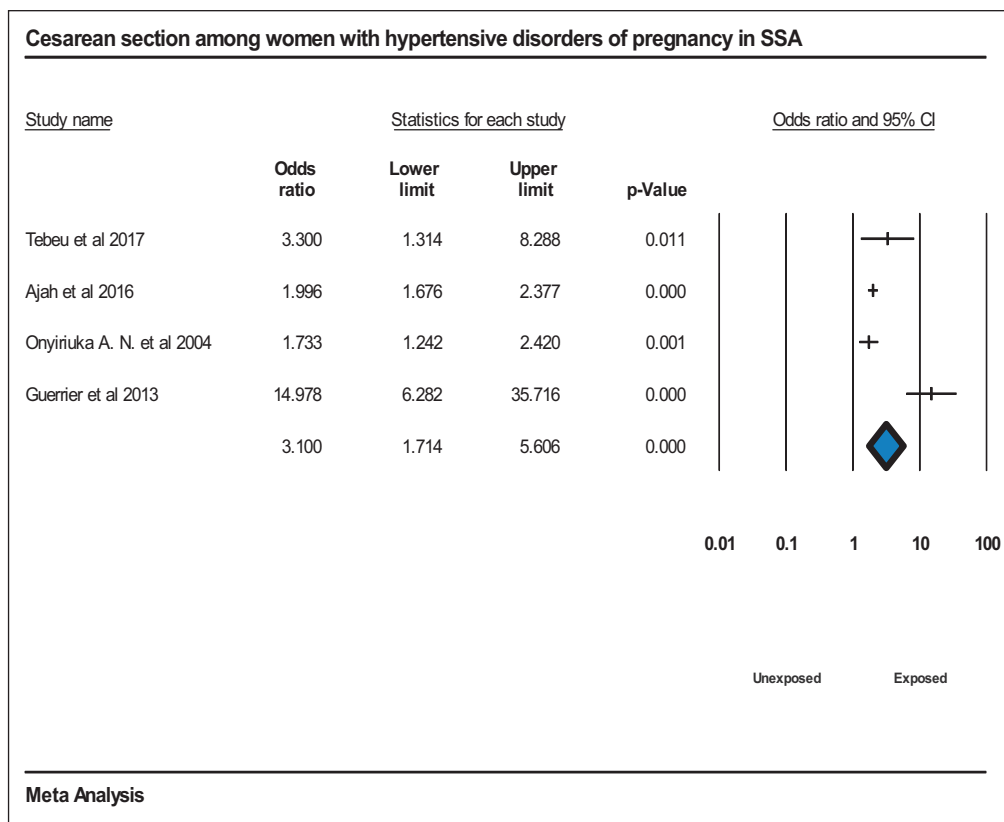
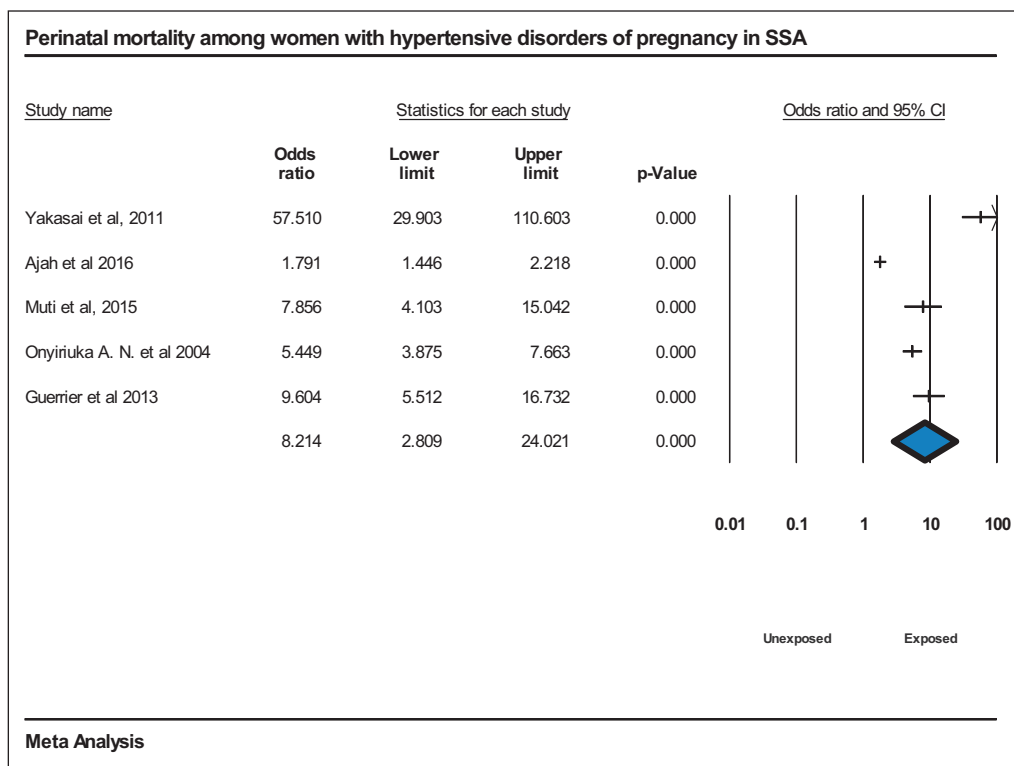


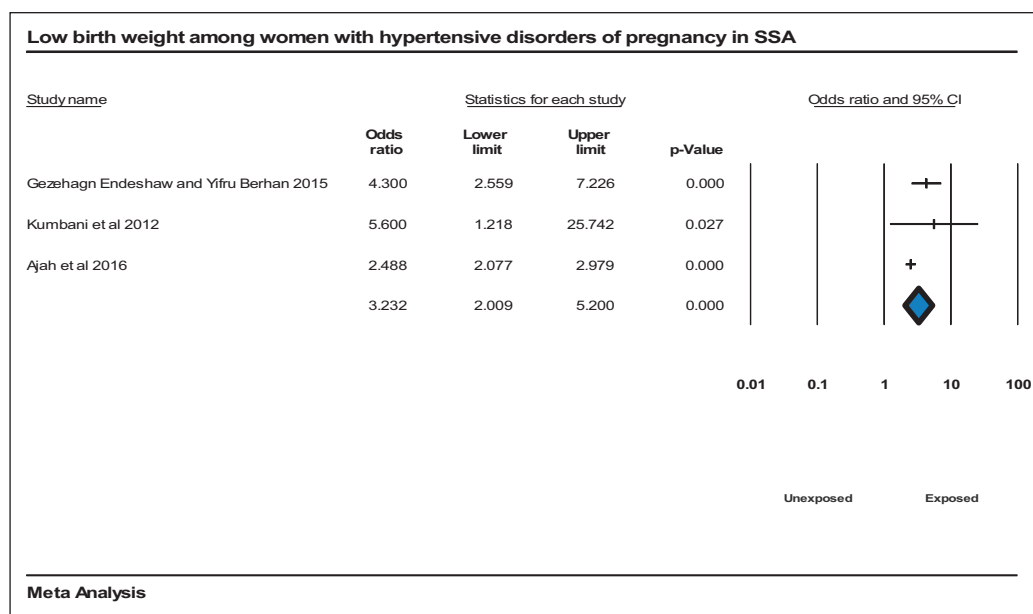
Figure 8. Forest plot displaying maternal mortality associated with hypertensive disorders of pregnancy in SSA.



**Figure 9.** Forest plot displaying cesarean section among women with hypertensive disorders of pregnancy in SSA.



**Figure 10.** Forest plot displaying perinatal mortality among women with hypertensive disorders of pregnancy in SSA.



**Figure 11.** Forest plot displaying low birth weight newborn among women with hypertensive disorders of pregnancy in SSA.

countries from Africa, Asia, Latin America, and the Middle East, the risk of death was nearly four times higher for women with preeclampsia than non-preeclamptic women, and for those with eclampsia, the risk increased exponentially.<sup>11</sup>

Women with HDP are more likely to have a cesarean section compared to normotensive pregnant women and significant pooled association indicates increased perinatal mortality. Similarly, the studies have shown the risk of fetal and neonatal deaths, as well as preterm birth and admission to a Neonatal Intensive Care Unit were increased in both preeclampsia and eclampsia.<sup>11</sup>

The pooled risk of preterm delivery and low birth weight newborn was high among women with HDP compared to normotensive pregnant women. Similarly, the studies have shown the more significant the severity of hypertension, the increased risk of complications associated with the pregnancy, and the greater the possibility of pregnancy termination.<sup>122,123</sup> HDP are associated with prematurity (which may be iatrogenic) and low birth weight even when corrected for gestation,<sup>124</sup> which is in line with the analysis of this study.

The pooled ORs of HDP and cesarean section, perinatal mortality, low birth weight, and preterm delivery have shown high heterogeneity. The geographic differences, ethnicity, socioeconomic status, adjustment for confounding, sampling error (within and between), and design aspects may contribute.

These findings have important policy implications for the treatment of HDP and pregnancy outcomes in SSA. The strong influence of HDP on maternal mortality, cesarean section, perinatal mortality, low birth weight, and preterm birth suggests that safe motherhood programs need to explore applicable methods of increasing maternal service

utilization among women of reproductive age, pregnant mothers, and mothers diagnosed with HDP in SSA. The review has revealed that preeclampsia and eclampsia prevalence is high. Therefore, attention should be given to improving women's health-seeking behavior, preeclampsia and eclampsia management protocol adherence. This calls for a rigorous evaluation of the effectiveness of existing antenatal and intranatal care programs in which prevention and management of HDP will be undertaken in SSA to identify gaps in policy and program implementation. Targeted interventions to strengthen the infrastructure of antenatal and intranatal care both for women and newborns should be considered.

Duval and Tweedie's trim and fill analysis using the random effect analysis showed adjusted values of 2 to the left and 4 to the right of the mean for chronic hypertension and eclampsia, respectively, although non-significant. Publication bias may be due to difficulty in accessing gray literature in SSA and less publication of non-significant results. In the analysis, checking study quality, sensitivity analysis, and acknowledging potential sources of bias were completed.

### *"Strengths and weaknesses" of study*

Studies were carefully selected according to a rigorous search strategy to enable unbiased inclusion of retrospective or prospective studied cohorts and cross-sectional studies. These studies were included if they calculated prevalence/proportion or mentioned pregnancy outcomes.

Despite the selection of relevant and appropriately performed studies, there was a range of reported incidences of HDP. There was difficulty in selecting studies of (any type



of) HDP and compiling the relevant data, particularly because HDP include various types of disorders and individual studies did not always assess every type. As a result, the overall prevalence of HDP may be liable to bias. There may also be bias due to differences in the selection of women studied, difficulties in measuring HDP, and true differences within the population of women. In addition, the authors failed to define the control group in the studies.

Most papers did not report relevant baseline demographics defining the studied population and this was not considered in the meta-analysis, which limited the assessment of confounders. Coexisting factors including maternal age and ethnicity, recognized to be associated with both HDP and adverse pregnancy outcome, may contribute to confounding, but their relative effects are unknown. Few studies in the meta-analysis reported control data, so a direct comparison of outcomes between women with HDP and normotensive women was not possible. We found substantial heterogeneity which may be partly explained by characteristics of the studies shown by subgroup analysis. The included studies were facility-based that may have a slightly elevated proportion of HDP compared to population-based study; hence, the findings may not represent true prevalence in the community. Also, a significant proportion of studies that included data with HDP and pregnancy outcomes were retrospective studies.

## Conclusion

The overall pooled prevalence of HDP was high compared to those reported from other regions. The meta-analysis indicates that HDP are associated with maternal mortality and cesarean section as well as adverse pregnancy outcomes such as preterm delivery, low birth weight, and perinatal mortality.

The meta-analysis supports the importance of increased antenatal surveillance for women with HDP to enable early identification of complications. Women should receive counseling to optimize their health during pregnancy and to inform them of the increased maternal and fetal risks associated with their hypertension. Strategies to predict those at greatest risk of HDP, determine optimal drug treatments, and reduce adverse pregnancy outcomes are needed.

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## Author contributions

All authors involved in the design, selection of articles, data extraction, statistical analysis, and manuscript writing. All authors read and approved the final draft of the manuscript.

## Availability of data and materials

All data pertaining to this study are contained and presented in this document.

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## Supplemental material

Supplemental material for this article is available online.

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