Interdisciplinary Research in Medical Sciences Specialty
ISSN: 3062-4401
2026, Volume 6, Issue 1, Page No: 134-144

Available online at: www.galaxypub.co/page/journals

Galaxy Publication

Evaluating ACC/AHA Blood Pressure Categories for Predicting Adverse Pregnancy Outcomes in Nulliparous Women

Patrick O'Connor[1]*, Grace Murphy[1], Niamh Walsh[2]

[1]Department of Obstetric Medicine and Hypertension, School of Medicine, University College Cork, Cork, Ireland.
[2]Department of Perinatal Epidemiology and Cardiovascular Risk, Faculty of Medicine, University of Galway, Galway, Ireland.

***E-mail** ✉ patrick.oconnor@ucc.ie

Received: 31 December 2025; **Revised:** 30 March 2026; **Accepted:** 04 April 2026

ABSTRACT

The American College of Cardiology and American Heart Association (ACC/AHA) updated their blood pressure (BP) criteria in 2017, establishing lower thresholds to identify hypertension in non-pregnant adults. Adoption of these revised standards in pregnant women might allow earlier recognition of individuals at greater risk for complications. This approach holds particular promise for stratifying risk among first-time mothers. The present secondary analysis of the SCOPE cohort evaluated whether these ACC/AHA BP groupings could effectively highlight nulliparous women of standard risk who are predisposed to poorer pregnancy results. Participants were drawn from the international SCOPE cohort and included all pregnancies reaching 20 weeks' gestation or beyond during the period 2004–2008. The majority of women were White, aged in their twenties, and possessed normal or elevated body mass index (BMI). Cases involving fetal demise prior to 20 weeks or pregnancy termination at any stage were omitted from the dataset. Classification of participants relied on the maximum BP value observed throughout gestation, applying ACC/AHA definitions: normal (BP <120/80 mmHg), "Elevated BP" (120–129 mmHg systolic with <80 mmHg diastolic), "Stage-1 hypertension" (systolic BP [sBP] 130–139 mmHg or diastolic BP [dBP] 80–89 mmHg), and "Stage-2 hypertension" (split into non-severe [sBP 140–159 mmHg or dBP 90–109 mmHg] and severe [sBP ≥160 mmHg or dBP ≥110 mmHg]). Key endpoints comprised preterm birth (PTB), birthweight below the 10th centile, postpartum hemorrhage, and requirement for neonatal unit care. Adjusted relative risks (aRRs) along with diagnostic accuracy measures were determined for each endpoint, both by direct comparison of BP categories to the normal reference group and by treating category boundaries as potential diagnostic cut-points. All models accounted for maternal age, BMI, smoking, ethnicity, and alcohol intake. From the original 5,628 women in the SCOPE study, 5,597 were eligible for inclusion. Severe "Stage 2 hypertension," relative to normal BP, correlated with markedly elevated occurrence of PTB (24.0% versus 5.3%; aRR 4.88, 95% CI [3.46 to 6.88]), birthweight <10th centile (24.4% versus 8.8%; aRR 2.70 [2.00 to 3.65]), and neonatal unit admission (32.9% versus 8.9%; aRR 3.40 [2.59 to 4.46]). Non-severe "Stage 2 hypertension" likewise showed associations with birthweight <10th centile (16.1% versus 8.8%; aRR 1.82 [1.45 to 2.29]) and neonatal unit admission (15.4% versus 8.9%; aRR 1.65 [1.31 to 2.07]). However, none of the BP categories below "Stage 2 hypertension" demonstrated any significant relationship with the examined adverse events. Assessment of individual BP levels as diagnostic thresholds revealed that only severe "Stage 2 hypertension" generated a strong positive likelihood ratio (LR) of 5.09 (95% CI [3.84 to 6.75]) for predicting PTB. Conversely, no BP cut-off proved effective at excluding the possibility of adverse outcomes, with all negative LRs remaining above 0.2. Important constraints of the work encompass the cohort's limited ethnic variety, reliance upon BP readings from routine clinical documentation close to delivery, the retrospective approach, inconsistent availability of BP data at every antenatal appointment, and incomplete descriptions of several outcome measures. Findings from this investigation indicate that the 2017 ACC/AHA BP classification system produces analogous associations and predictive characteristics among nulliparous women as those documented in the wider obstetric setting. Thresholds situated below the conventional "Stage 2 hypertension" definition failed to correlate with heightened chances of preterm birth, low birthweight, postpartum hemorrhage, or neonatal unit admission. Consequently, the evidence does not favor incorporating these reduced BP values to signify abnormality in nulliparous pregnancies.

Keywords: ACC/AHA, Blood pressure, Nulliparous women, Pregnancy

How to Cite This Article: O'Connor P, Murphy G, Walsh N. Evaluating ACC/AHA Blood Pressure Categories for Predicting Adverse Pregnancy Outcomes in Nulliparous Women. Interdiscip Res Med Sci Spec. 2026;6(1):134-44. https://doi.org/10.51847/zUa9tesTq1

Introduction

Global agreement establishes hypertension in non-pregnant individuals as a systolic blood pressure (sBP) of 140 mmHg or higher, or a diastolic blood pressure (dBP) of 90 mmHg or higher [1, 2]. Defined according to these parameters, hypertension during pregnancy flags increased likelihood of complications affecting mothers, fetuses, and newborns [3]. Such elevated risks are well documented, regardless of whether blood pressure rises prior to pregnancy or before 20 weeks' gestation (chronic hypertension) or from 20 weeks onward (gestational hypertension) [4, 5]. Accurate categorization of hypertensive disorders in pregnancy and effective control of elevated BP therefore play a central role in reducing poor outcomes.

In 2017, the American College of Cardiology/American Heart Association (ACC/AHA) revised their criteria for abnormal BP in non-pregnant populations. This change reflected the established continuous link between rising BP and cardiovascular disease, whose incidence continues to increase [6, 7]. The ACC/AHA reclassified hypertension into "Stage 1 hypertension" (BP 130–139/80–89 mmHg) and "Stage 2 hypertension" (BP ≥140/90 mmHg), while introducing an "Elevated" BP category (sBP 120–129 mmHg with dBP <80 mmHg) positioned between this range and "Normal" BP (<120/80 mmHg) [8].

Research has confirmed a continuous association between BP levels during pregnancy and adverse perinatal results [9–11]. Nevertheless, clinical guidelines necessitate clear thresholds to guide risk assessment and allocation of healthcare resources. Existing studies on the 2017 ACC/AHA BP thresholds and pregnancy complications have primarily examined measurements obtained before 20 weeks' gestation as predictors of preeclampsia and related issues [12–16], rather than assessing the diagnostic performance of the various cutoffs. Only a limited number of reports have specifically addressed nulliparous women [17, 18], a group that carries elevated risk for hypertensive disorders of pregnancy (HDP) relative to multiparous women with a history of normotensive pregnancies.

Although some experts have advocated adopting the 2017 ACC/AHA BP categories in pregnant women [19], these recommendations have not been incorporated into guidelines from the American College of Obstetricians and Gynecologists (ACOG) or international bodies [1]. The current study therefore evaluated, within a cohort of standard-risk nulliparous women, the value of applying the 2017 ACC/AHA BP categories to detect increased likelihood of preterm birth (PTB), small-for-gestational age (SGA) birthweight, postpartum hemorrhage (PPH), and neonatal intensive care unit (NICU) admission—outcomes known to be associated with hypertension.

Materials and Methods

The SCOPE study

SCOPE (Screening for Pregnancy Endpoints) constituted an international, multicenter, prospective cohort investigation involving standard-risk nulliparous women carrying singleton pregnancies. Its primary objective was to create screening tools capable of forecasting frequent pregnancy complications. The protocol received approval from the appropriate local ethics committees (New Zealand AKX/02/00/364, Australia REC 1712/5/2008, London, Leeds and Manchester 06/MRE01/98, and Cork ECM5 (10) 05/02/08). Detailed methods have been described elsewhere [20].

Briefly, between November 2004 and September 2008, potentially suitable women were invited to join the study upon presentation for routine antenatal care at six participating centers: Auckland, New Zealand; Adelaide, Australia; London, Manchester, and Leeds, United Kingdom; and Cork, Ireland. Eligibility required nulliparous status with a singleton pregnancy between 14+0 and 16+6 weeks' gestation; this group included women with a history of chronic hypertension not currently managed with medication. Women were excluded if they were deemed high risk for preeclampsia, PTB, or SGA infants (including those with pre-pregnancy treated chronic hypertension, preexisting diabetes, renal disease, systemic lupus erythematosus, or antiphospholipid syndrome), if they carried a major fetal anomaly, presented with BP ≥160/100 mmHg at the initial antenatal visit, or were using low-dose aspirin, calcium supplements, fish oil, or heparin.

All participants provided written informed consent. The study schedule included two antenatal research visits (at 14–16 weeks and 19–21 weeks) plus a postnatal assessment within 48 hours of delivery. At each visit, midwives measured BP using pregnancy-validated devices. Measurements were taken twice with a mercury or aneroid sphygmomanometer, followed by a MICROLIFE BP 3AC1-2 monitor; the second reading from each method was documented. Additional clinical information was extracted from antenatal records at every visit, encompassing demographic details, medical background, prior obstetric history, and familial medical and obstetric conditions.

Maternal and infant charts were also reviewed for BP readings documented in the final two weeks before labor onset, as well as for maternal and perinatal results. Outcome data were derived from medical chart reviews and diagnostic coding systems according to local availability at each participating site. Recorded outcomes encompassed gestational hypertension (defined as systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg in the latter half of pregnancy), with or without preeclampsia, and preeclampsia on its own (characterized as gestational hypertension accompanied by proteinuria, including cases superimposed on chronic hypertension).

BP and adverse pregnancy outcome

This secondary examination of the SCOPE dataset explored links between the maximum blood pressure attained during antenatal care and complications tied to hypertensive disorders in pregnancy. Only pregnancies featuring blood pressure recordings from a minimum of one study visit and complete information on at least one maternal or perinatal endpoint were retained. The SCOPE Research Committee authorized this work in accordance with the parent study's foundational ethical permissions [21].

Maximum antenatal BP was established by reviewing readings taken across three standardized intervals—namely 14–16 weeks, 19–21 weeks, and the two weeks immediately prior to delivery—as documented in the original SCOPE protocol. These values were grouped using the 2017 ACC/AHA framework as follows: "Normal" BP (<120/<80 mmHg), "Elevated BP" (sBP 120–129 mmHg with dBP <80 mmHg), "Stage 1 hypertension" (sBP 130–139 mmHg or dBP 80–89 mmHg), and "Stage 2 hypertension," subdivided into non-severe (sBP 140–159 mmHg or dBP 90–109 mmHg) and severe (sBP ≥160 mmHg or dBP ≥110 mmHg) [22]. A supplementary sensitivity analysis relied exclusively on BP data collected at the 14–16 week visit.

Primary endpoints of interest included PTB, SGA, PPH, and NICU admission. PTB referred to any delivery occurring before 37+0 weeks of gestation. SGA was identified as birthweight falling below the 10th percentile on customized growth charts adjusted for maternal height and weight, parity, ethnic background, and newborn sex [23, 24]. PPH involved an estimated blood loss of at least 1,000 ml.

Statistical analysis

Maternal baseline characteristics and the distribution of peak BP categories were presented through summary statistics for the entire cohort and within each 2017 ACC/AHA BP stratum. Comparative differences across groups were quantified, although p-values were deliberately omitted to align with STROBE recommendations.

The existence of a possible graded relationship between BP classification and adverse perinatal events was evaluated using two complementary strategies based on available peak BP determinations for each pregnancy. No procedures for missing data imputation were applied.

Initially, BP categories were modeled as exclusive groups. Employing the "Normal BP" group as the referent, adjusted risk ratios (aRRs) with accompanying 95% confidence intervals (CIs) were generated through Poisson regression equipped with robust standard errors [25]. Covariates in the adjustment included maternal age, body mass index (BMI), ethnicity, smoking habits, and alcohol consumption. This evaluation represented an extension beyond the specifications detailed in the original Research Application Form (S1 Text: Application Form–SCOPE Research Project).

Subsequently, comparable regression models were applied, with the bottom edge of each BP category functioning as a diagnostic threshold for identifying abnormal blood pressure. In practice, this meant contrasting women whose BP reached or surpassed the threshold against those remaining below it. As an illustration, the "Stage 1 hypertension" cutoff involved comparing outcomes for women exhibiting sBP ≥130 mmHg or dBP ≥80 mmHg with those showing sBP <130 mmHg and dBP <80 mmHg. Performance of these thresholds was quantified via sensitivity, specificity, positive likelihood ratio (+LR), and negative likelihood ratio (-LR). The +LR was derived by dividing sensitivity by one minus specificity, and the -LR by dividing one minus sensitivity by specificity. Associated confidence intervals followed standard computational approaches [26]. Thresholds yielding sensitivity or specificity above 80% were viewed as strong. Likelihood ratios were deemed "good" when they substantially modified the pretest probability of an adverse event, specifically when +LR reached 5.0 or higher or -LR fell below 0.2, per accepted interpretive guidelines [27].

A further sensitivity analysis limited BP assessments to the early pregnancy period (14–16 weeks' gestation) and expanded the outcomes to encompass preeclampsia as well as gestational hypertension, either alone or combined with preeclampsia.

All computations were executed in R statistical software, release 4.1.2. Reporting of this investigation followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

Results and Discussion

Out of 5,628 women initially recruited into the SCOPE cohort, 31 were ineligible for inclusion owing to early fetal loss before 20 weeks' gestation (n = 12), elective termination for fetal anomaly (n = 17), or spontaneous preterm labor prior to 22 weeks (n = 2). The analysis ultimately incorporated data from 5,597 pregnancies.
Peak blood pressure most commonly arose in the final two weeks before delivery (4,827 cases, 86%), as opposed to the visit at 19–21 weeks (428 cases, 8%) or 14–16 weeks (342 cases, 6%).
Table 1 (gray column) reveals that the typical participant was in her late twenties with a body mass index situated in the normal-to-overweight spectrum. The cohort was predominantly White (90.0%), although various ethnic minorities were present, especially women of East Asian, South Asian, and Māori/Pacific Islander descent. Using the New Zealand Socioeconomic Index (NZSEI score), 19.6% of participants were categorized as experiencing social deprivation below the threshold of 24. Prevalent preexisting conditions included anemia and polycystic ovary syndrome, while chronic hypertension was reported by fewer than 1% of women. Family medical histories were common, led by chronic hypertension, followed by hypertensive disorders of pregnancy, ischemic heart disease, and type 2 diabetes mellitus.

Table 1. Baseline characteristics overall and stratified by maximum antenatal BP based on 2017 ACC-AHA categories (N women (%) unless otherwise stated).

		Total	"Normal BP"	"Elevated BP"	"Stage 1 HTN"	"Stage 2 HTN"		
						All	Stage 2 (Non-severe)	Stage 2 (Severe)
Total N (Ł)		5,597 (100)	1,302 (23.3)	1,056 (18.9)	1,944 (34.7)	1,295 (23.1)	1,070 (19.1)	225 (4.0)
Demographics								
Maternal age#		28.7 (5.5)	28.9 (5.4)	28.4 (5.6)	28.7 (5.5)	28.6 (5.4)	28.7 (5.3)	28.1 (5.9)
BMI (kg/m^2)#^		25.3 (4.9)	23.2 (3.5)	24.7 (4.4)	25.6 (4.8)	27.4 (5.8)	27.1 (5.5)	28.8 (6.8)
Ethnicity								
White		5,038 (90.0)	1,076 (82.6)	959 (90.8)	1,801 (92.6)	1,202 (92.8)	999 (93.4)	203 (90.2)
East Asian		168 (3.0)	85 (6.5)	31 (2.9)	33 (1.7)	19 (1.5)	15 (1.4)	4 (1.8)
Other		80 (1.4)	26 (2.0)	15 (1.4)	23 (1.2)	16 (1.2)	14 (1.3)	2 (0.9)
Māori/Pacific Islander		112 (2.0)	30 (2.3)	23 (2.2)	35 (1.8)	24 (1.9)	17 (1.6)	7 (3.1)
Afro-Caribbean		65 (1.2)	25 (1.9)	9 (0.9)	18 (0.9)	13 (1.0)	8 (0.7)	5 (2.2)
South Asian		134 (2.4)	60 (4.6)	19 (1.8)	34 (1.7)	21 (1.6)	17 (1.6)	4 (1.8)
Socioeconomic index (<24)		1,099 (19.6)	201 (15.4)	210 (19.9)	407 (20.9)	281 (21.7)	226 (21.1)	55 (24.4)
Preexisting medical problems								
Chronic hypertension (mild, no treatment)		45 (0.8)	2 (0.2)	4 (0.4)	18 (0.9)	21 (1.6)	15 (1.4)	6 (2.7)
Epilepsy		46 (0.8)	8 (0.6)	11 (1.0)	11 (0.6)	16 (1.2)	13 (1.2)	3 (1.3)
Polycystic ovarian syndrome		353 (6.3)	94 (7.2)	67 (6.3)	112 (5.8)	80 (6.2)	65 (6.1)	15 (6.7)
Anemia		738 (13.2)	179 (13.7)	143 (13.5)	269 (13.8)	147 (11.4)	128 (12.0)	19 (8.4)
Rheumatoid arthritis		31 (0.6)	4 (0.3)	5 (0.5)	13 (0.7)	9 (0.7)	8 (0.7)	1 (0.4)
History among first degree relatives								
Chronic hypertension		2,301 (41.1)	460 (35.3)	432 (40.9)	774 (39.8)	635 (49.0)	517 (48.3)	118 (52.4)
Type 1 diabetes mellitus		114 (2.0)	26 (2.0)	17 (1.6)	41 (2.1)	30 (2.3)	23 (2.1)	7 (3.1)
Type 2 diabetes mellitus		606 (10.8)	139 (10.7)	111 (10.5)	205 (10.5)	151 (11.7)	124 (11.6)	27 (12.0)
Ischemic heart disease		900 (16.1)	175 (13.4)	171 (16.2)	301 (15.5)	253 (19.5)	199 (18.6)	54 (24.0)
Cardiovascular accident		295 (5.3)	68 (5.2)	50 (4.7)	91 (4.7)	86 (6.6)	68 (6.4)	18 (8.0)
Any hypertensive disorder of pregnancy		1,046 (18.7)	174 (13.4)	175 (16.6)	380 (19.5)	317 (24.5)	253 (23.6)	64 (28.4)
Preeclampsia		514 (9.2)	80 (6.1)	86 (8.1)	182 (9.4)	166 (12.8)	135 (12.6)	31 (13.8)
Current pregnancy								
Nulliparous		ALL						
Conceived by artificial reproductive technologies		353 (6.3)	84 (6.5)	83 (7.9)	107 (5.5)	79 (6.1)	68 (6.4)	11 (4.9)
Smoking status at first SCOPE visit	No smoking	4,243 (75.8)	1,028 (79.0)	795 (75.3)	1,438 (74.0)	982 (75.8)	821 (76.7)	161 (71.6)
	Quit smoking	753 (13.5)	138 (10.6)	146 (13.8)	288 (14.8)	181 (14.0)	144 (13.5)	37 (16.4)
	Smoking	601 (10.7)	136 (10.4)	115 (10.9)	218 (11.2)	132 (10.2)	105 (9.8)	27 (12.0)
Alcohol status at first SCOPE visit	No alcohol	2,173 (38.8)	516 (39.6)	458 (43.4)	691 (35.5)	508 (39.2)	406 (37.9)	102 (45.3)
	Quit drinking	2,855 (51.0)	660 (50.7)	504 (47.7)	1,030 (53.0)	661 (51.0)	563 (52.6)	98 (43.6)
	Continued to drink	569 (10.2)	126 (9.7)	94 (8.9)	223 (11.5)	126 (9.7)	101 (9.4)	25 (11.1)
Multivitamin at first SCOPE visit	No	2,760 (49.3)	644 (49.5)	499 (47.3)	955 (49.1)	662 (51.1)	546 (51.0)	116 (51.6)
	Yes	2,820 (50.4)	654 (50.2)	553 (52.4)	980 (50.4)	633 (48.9)	524 (49.0)	109 (48.4)
Folate at first SCOPE visit	No	1,697 (30.3)	387 (29.7)	316 (29.9)	599 (30.8)	395 (30.5)	322 (30.1)	73 (32.4)
	Yes	3,900 (69.7)	915 (70.3)	740 (70.1)	1,345 (69.2)	900 (69.5)	748 (69.9)	152 (67.6)

* The highest antenatal BP was determined from values at the 3 time points available (i.e., 14–16 weeks, 19–21 weeks, and during the 2 weeks before birth), as part of the original SCOPE data collection. BP was categorized according to the 2017 ACC/AHA criteria as follows: normal (sBP <120 mmHg and dBP <80 mmHg), elevated (sBP 120–129 mmHg but dBP <80 mmHg), stage 1 hypertension (sBP 130–139 mmHg or dBP 80–89 mmHg), and stage 2 hypertension (sBP ≥140 mmHg or dBP ≥ 90mmHg).
Ł Where women are missing from data points, percentages are calculated from total number of women with data available.
Mean (standard deviation).
^ BMI recorded at booking visit.
ACC, American College of Cardiology; AHA, American Heart Association; BMI, body mass index; BP, blood pressure; dBP, diastolic blood pressure; HTN, hypertension; sBP, systolic blood pressure.

https://doi.org/10.1371/journal.pmed.1004471.t001

All women in the current pregnancy were nulliparous per the study's eligibility requirements, with assisted reproductive technologies used in only a small proportion **(Table 1)**, (gray column). The majority did not smoke or stopped smoking upon learning of their pregnancy and refrained from alcohol consumption during gestation. At the initial research visit (14–16 weeks), roughly half the cohort used multivitamins and two-thirds took folic acid. Throughout pregnancy, 23.3% of women stayed within normal BP limits, 18.9% were categorized as "Elevated BP," 34.7% as "Stage-1 hypertension," and 23.1% as "Stage-2 hypertension" (comprising 19.1% non-severe and 4% severe cases) **(Table 1)**, (white columns).

Maternal characteristics varied notably by BP category **(Table 1)**, (white columns). Those assigned to higher BP strata tended to have greater BMI, were more often White, and showed higher rates of social deprivation on the NZSEI scale. Advancing BP category was further linked to increased personal or familial occurrence of chronic hypertension, as well as family histories of hypertensive pregnancy disorders or ischemic heart disease.

Table 2 (gray column) indicates an average gestational age at birth just below 40 weeks, with labor induction performed in about one-third of pregnancies. Operative vaginal deliveries accounted for over one-quarter of births, while cesarean sections occurred in a slightly higher proportion. A single maternal death was recorded. Preeclampsia was diagnosed in 5.0% of the overall sample and gestational hypertension in 8.4%.

Table 2. Labor, delivery, and maternal-perinatal outcomes overall and by peak antenatal BP using 2017 ACC/AHA categories (mean ± SD or median [IQR] or N (%) unless otherwise stated).

	Total	"Normal BP"	"Elevated BP"	"Stage 1 HTN"	"Stage 2 HTN"		
					All	"Stage 2" (Non-severe)	"Stage 2" (Severe)
Total N (Ł)	5,597	1,302 (23.3)	1,056 (18.9)	1,944 (34.7)	1,295 (23.1)	1,070 (19.1)	225 (4.0)
Labor and delivery outcomes							
GA delivery (weeks)	39.7 (2.0)	39.6 (2.0)	39.7 (2.0)	39.9 (1.8)	39.3 (2.3)	39.6 (2.1)	38.0 (2.9)
Induction or prelabor rupture of membranes + augmentation	1,830 (32.7)	336 (25.8)	292 (27.7)	617 (31.7)	585 (45.2)	454 (42.4)	131 (58.2)
(Missing)	*83 (1.5)*	*32 (2.5)*	*16 (1.5)*	*18 (0.9)*	*17 (1.3)*	*17 (1.6)*	*0 (0.0)*
Mode of birth							
Unassisted vaginal	2,521 (45.0)	629 (48.3)	501 (47.4)	905 (46.6)	486 (37.5)	413 (38.6)	73 (32.4)
Operative vaginal	1,482 (26.5)	354 (27.2)	277 (26.2)	514 (26.4)	337 (26.0)	293 (27.4)	44 (19.6)
Prelabor cesarean	498 (8.9)	106 (8.1)	78 (7.4)	135 (6.9)	179 (13.8)	124 (11.6)	55 (24.4)
Cesarean (in labor)	1,093 (19.5)	211 (16.2)	200 (18.9)	389 (20.0)	293 (22.6)	240 (22.4)	53 (23.6)
Maternal death antepartum	1 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
(Missing)	*2 (0.0)*	*2 (0.2)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*
Maternal morbidity							
Type of HDP							
Chronic hypertension	17 (0.3)	0 (0.0)	0 (0.0)	1 (0.1)	16 (1.2)	8 (0.7)	8 (3.6)
Missing	24 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	24 (1.9)	16 (1.5)	8 (3.6)
Preeclampsia	278 (5.0)	1 (0.1)	0 (0.0)	6 (0.3)	271 (20.9)	143 (13.4)	128 (56.9)
Missing	*5 (0.1)*	*5 (0.4)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*
Gestational hypertension	470 (8.4)	0 (0.0)	0 (0.0)	4 (0.2)	466 (36.0)	382 (35.7)	84 (37.3)
Serious maternal complications							
Placental abruption	41 (0.7)	8 (0.6)	7 (0.7)	11 (0.6)	15 (1.2)	9 (0.8)	6 (2.7)
Major postpartum hemorrhage	227 (4.1)	45 (3.5)	42 (4.0)	71 (3.7)	69 (5.3)	62 (5.8)	7 (3.1)
(Missing)	*909 (16.2)*	*182 (14.0)*	*115 (10.9)*	*365 (18.8)*	*247 (19.1)*	*215 (20.1)*	*32 (14.2)*
Fetal and neonatal outcomes							
Fetal outcome							
Intrauterine fetal death/stillbirth	24 (0.4)	6 (0.5)	5 (0.5)	8 (0.4)	5 (0.4)	3 (0.3)	2 (0.9)
Liveborn	5,566 (99.4)	1,294 (99.4)	1,050 (99.4)	1,935 (99.5)	1,287 (99.4)	1,065 (99.5)	222 (98.7)
Neonatal death	7 (0.1)	2 (0.2)	1 (0.1)	1 (0.1)	3 (0.2)	2 (0.2)	1 (0.4)
Preterm birth							
<34 weeks	108 (1.9)	24 (1.8)	16 (1.5)	23 (1.2)	45 (3.5)	20 (1.9)	25 (11.1)
<37 weeks (total)	342 (6.1)	69 (5.3)	54 (5.1)	94 (4.8)	125 (9.7)	69 (6.4)	56 (24.9)
<37 weeks (spontaneous)	231 (4.1)	58 (4.5)	48 (4.5)	79 (4.1)	46 (3.6)	41 (3.8)	5 (2.2)
Sex							
Male	2,840 (50.7)	662 (50.8)	514 (48.7)	1,016 (52.3)	648 (50.0)	533 (49.8)	115 (51.1)
Female	2,757 (49.3)	640 (49.2)	542 (51.3)	928 (47.7)	647 (50.0)	537 (50.2)	110 (48.9)
Birthweight							
Small for gestational age	624 (11.1)	115 (8.8)	94 (8.9)	188 (9.7)	227 (17.5)	172 (16.1)	55 (24.4)
Large for gestational age	531 (9.5)	130 (10.0)	118 (11.2)	170 (8.7)	113 (8.7)	92 (8.6)	21 (9.3)
Missing	*3 (0.1)*	*1 (0.1)*	*2 (0.2)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*	*0 (0.0)*
Low Apgar score (<7 at 5 min)	61 (1.1)	12 (0.9)	12 (1.1)	15 (0.8)	22 (1.7)	16 (1.5)	6 (2.7)
Missing	*60 (1.1)*	*29 (2.2)*	*9 (0.9)*	*14 (0.7)*	*8 (0.6)*	*6 (0.6)*	*2 (0.9)*
Intubation at birth							
Yes	49 (0.9)	6 (0.5)	11 (1.0)	11 (0.6)	21 (1.6)	15 (1.4)	6 (2.7)
(Missing)	*29 (0.5)*	*14 (1.1)*	*0 (0.0)*	*7 (0.4)*	*8 (0.6)*	*7 (0.7)*	*1 (0.4)*
Admission to NICU	647 (11.6)	116 (8.9)	102 (9.7)	190 (9.8)	239 (18.5)	165 (15.4)	74 (32.9)

Stillbirth defined as fetal death in utero ≥20+0 weeks gestation.

* The highest antenatal BP was determined from values at the 3 time points available (i.e., 14–16 weeks, 19–21 weeks, and during the 2 weeks before birth), as part of the original SCOPE data collection. BP was categorized according to the 2017 ACC/AHA criteria as follows: "Normal" (sBP <120 mmHg and dBP <80 mmHg), "Elevated BP" (sBP 120–129 mmHg but dBP <80 mmHg), "Stage 1 hypertension" (sBP 130–139 mmHg and/or dBP 80–89 mmHg), and "Stage 2 hypertension" (sBP ≥140 mmHg and/or dBP ≥90 mmHg).

Ł Where women are missing from data points, percentages are calculated from total number of women with data available.

ACC, American College of Cardiology; AHA, American Heart Association; BP, blood pressure; dBP, diastolic blood pressure; HTN, hypertension; NA, not applicable; NICU, neonatal intensive care unit; sBP, systolic blood pressure.

https://doi.org/10.1371/journal.pmed.1004471.t002

Substantial differences in pregnancy outcomes emerged across BP categories **(Table 2)**, (white columns). Higher BP groups exhibited increased tendencies toward preterm delivery, more frequent labor induction, and elevated cesarean rates (both pre-labor and intrapartum). These women also displayed greater likelihood of untreated chronic hypertension, development of preeclampsia or gestational hypertension, placental abruption (but not postpartum hemorrhage), birth before 34 or 37 weeks, delivery of an SGA infant, low 5-minute Apgar scores (<7), and NICU admission. Consistent with diagnostic requirements, hypertensive disorders of pregnancy were largely confined to the "Stage 2 hypertension" category.

Table 3 demonstrates clear associations of "Stage 2 hypertension," most prominently its severe subtype, with PTB, SGA infants, and NICU admission. Links between BP strata and PPH risk remained ambiguous. Results were comparable in both unadjusted and covariate-adjusted models.

Table 3. Adjusted risk ratios with 95% CIs for adverse pregnancy outcomes according to peak antenatal BP using 2017 ACC-AHA categories (mmHg).

	Antenatal BP (mmHg)ǂ				
	Normal	**"Elevated BP"**	**"Stage 1 HTN"**	**"Stage 2 HTN" (Non-severe)**	**"Stage 2 HTN" (Severe)**
	<120/<80	**120–129/<80**	**130–139/80–89**	**140–159/90–109**	**≥160/≥110**
	(*N* = 1,302)	**(*N* = 1,056)**	**(*N* = 1,944)**	**(*N* = 1,070)**	**(*N* = 225)**
PPH >1L					
Event rate (n/N)	45/1,120	42/941	71/1,579	62/855	7/193
RR [95% CI]	1.00 (Ref)	1.11 (0.74, 1.68)	1.12 (0.78, 1.61)	1.80 (1.24, 2.62)	0.90 (0.41, 1.97)
aRR [95% CI]	1.00 Ref	1.09 (0.72, 1.65)	1.04 (0.72, 1.50)	1.58 (1.07, 2.33)	0.72 (0.32, 1.62)
Preterm birth					
Event rate (n/N)	69/1,302	54/1,056	94/1,944	69/1,070	54/225
RR [95% CI]	1.00 (Ref)	0.96 (0.68, 1.36)	0.91 (0.67, 1.23)	1.22 (0.88, 1.68)	**4.70 (3.40, 6.49)**
aRR [95% CI]	1.00 (Ref)	0.97 (0.68, 1.37)	0.94 (0.69, 1.27)	1.26 (0.90, 1.76)	**4.88 (3.46, 6.88)**
Birthweight <10th centile					
Event rate (n/N)	115/1,302	94/1,056	188/1,944	172/1,070	55/225
RR [95% CI]	1.00 (Ref)	1.01 (0.78, 1.31)	1.09 (0.88, 1.37)	**1.82 (1.46, 2.27)**	**2.77 (2.07, 3.69)**
aRR [95% CI]	1.00 (Ref)	1.02 (0.79, 1.33)	1.09 (0.87, 1.37)	**1.82 (1.45, 2.29)**	**2.70 (2.00, 3.65)**
Neonatal unit admission					
Event rate (n/N)	116/1,302	102/1,056	190/1,944	165/1,070	74/225
RR [95% CI]	1.00 (Ref)	1.08 (0.84, 1.40)	1.10 (0.88, 1.37)	**1.73 (1.38, 2.16)**	**3.69 (2.86, 4.76)**
aRR [95% CI]	1.00 (Ref)	1.05 (0.81, 1.35)	1.06 (0.84, 1.32)	**1.65 (1.31, 2.07)**	**3.4 (2.59, 4.46)**

* The highest antenatal BP was determined from values at the 3 time points available (i.e., 14–16 weeks, 19–21 weeks, and during the 2 weeks before birth), as part of the original SCOPE data collection. BP was categorized according to the 2017 ACC/AHA criteria as follows: "Normal" (sBP <120 mmHg and dBP <80 mmHg), "Elevated BP" (sBP 120–129 mmHg but dBP <80 mmHg), "Stage 1 hypertension" (sBP 130–139 mmHg and/or dBP 80–89 mmHg), and "Stage 2 hypertension" (sBP ≥140 mmHg and/or dBP ≥90 mmHg). Risk ratios and 95% CIs were estimated using Poisson regression with robust standard errors, using "Normal" BP as the reference category. RRs were adjusted for maternal age, BMI at booking, ethnicity, smoking status, and alcohol use.

ACC, American College of Cardiology; AHA, American Heart Association; aRR, adjusted risk ratio; BMI, body mass index; BP, blood pressure; CI, confidence interval; dBP, diastolic blood pressure; HTN, hypertension; PPH, postpartum hemorrhage; sBP, systolic blood pressure.

https://doi.org/10.1371/journal.pmed.1004471.t003

Table 4 presents the diagnostic characteristics of each BP category when used as a threshold indicating abnormal blood pressure. The "Elevated BP" category alone achieved sensitivity of 80% or higher for any outcome; however, its specificity remained poor (below 25%). Specificity reached 80% or more solely for the severe "Stage 2 hypertension" category across all studied outcomes. A good positive likelihood ratio (+LR) was observed only for "Stage 2 hypertension" in relation to PTB, while the upper bounds of the 95% confidence intervals for +LR fell below 5.0 for all other outcomes. No negative likelihood ratio point estimate or its lower 95% confidence interval met the criterion for clinical utility (i.e., <0.20), meaning none could reliably indicate that adverse events were improbable.

Table 4. Sensitivity, specificity, and likelihood ratios for SCOPE outcomes according to peak antenatal BP using thresholds from the 2017 ACC/AHA categories.

	Antenatal BP (mmHg)*				
	Normal	**"Elevated BP"**	**"Stage 1 HTN"**	**"Stage 2 HTN" (Non-severe)**	**"Stage 2 HTN" (Severe)**
	<120/<80	**120–129/<80**	**130–139/80–89**	**140–159/90–109**	**≥160/≥110**
	(*N* = 1,302)	**(*N* = 1,056)**	**(*N* = 1,944)**	**(*N* = 1,070)**	**(*N* = 225)**
PPH >1L					
Event rate (n/N)	227/4,688	182/3,571	140/2,627	69/1,048	7/193
Sensitivity [95% CI]	*Ref*	0.80 (0.74, 0.85)	0.62 (0.55, 0.68)	0.30 (0.24, 0.37)	0.03 (0.01, 0.06)
Specificity [95% CI]	*Ref*	0.24 (0.23, 0.25)	0.44 (0.43, 0.46)	0.78 (0.77, 0.79)	0.96 (0.95, 0.96)
LR positive [95% CI]ł	*Ref*	1.06 (0.99, 1.13]	1.11 (1.00, 1.23)	1.39 (1.13, 1.70)	0.74 (0.35, 1.55)
LR negative [95% CI]ł	*Ref*	0.82 (0.63, 1.07]	0.87 (0.73, 1.02)	0.89 (0.82, 0.97)	1.01 (0.99, 1.04)
Preterm birth					
Event rate (n/N)	342/5,597	273/4,295	219/3,239	125/1,295	56/255
Sensitivity [95% CI]	*Ref*	0.80 (0.75, 0.84)	0.64 (0.59, 0.69)	0.37 (0.31, 0.42)	0.16 (0.13, 0.21)
Specificity [95% CI]	*Ref*	0.23 (0.22, 0.25)	0.43 (0.41, 0.44)	0.78 (0.77, 0.79)	0.97 (0.96, 0.97)
LR positive [95% CI]ł	*Ref*	1.06 (1.02, 1.11)	1.11 (1.03, 1.21)	1.64 (1.42, 1.90)	5.09 (3.84, 6.75)
LR negative [95% CI]ł	*Ref*	0.80 (0.68, 0.95)	0.85 (0.73, 0.98)	0.82 (0.75, 0.89)	0.86 (0.82, 0.91)
Birthweight <10th percentile					
Event rate (n/N)		509/4,295	415/3,239	227/1,295	55/225
Sensitivity [95% CI]	*Ref*	0.82 (0.78, 0.85)	0.67 (0.63, 0.70)	0.36 (0.33, 0.40)	0.09 (0.07, 0.11)
Specificity [95% CI]	*Ref*	0.24 (0.23, 0.25)	0.43 (0.42, 0.45)	0.79 (0.77, 0.80)	0.97 (0.96, 0.97)
LR positive [95% CI]ł	*Ref*	1.07 (1.03, 1.12)	1.17 (1.10, 1.24)	1.69 (1.51, 1.90)	2.58 (1.92, 3.45)
LR negative [95% CI]ł	*Ref*	0.77(0.65, 0.92)	0.78 (0.69, 0.87)	0.81 (0.76, 0.86)	0.94 (0.92, 0.97)
Neonatal unit admission					
Event rate (n/N)		531/4,295	429/3,239	239/1,295	74/225
Sensitivity [95% CI]	*Ref*	0.82 (0.79, 0.85)	0.66 (0.63, 0.70)	0.37 (0.33, 0.41)	0.11 (0.09, 0.14)
Specificity [95% CI]	*Ref*	0.24 (0.23, 0.25)	0.43 (0.42, 0.45)	0.79 (0.77, 0.80)	0.97 (0.96, 0.97)
LR positive [95% CI]ł	*Ref*	1.08 (1.04, 1.12)	1.17 (1.10, 1.24)	1.73 (1.54, 1.94)	3.75 (2.87, 4.89)
LR negative [95% CI]ł	*Ref*	0.75 (0.63, 0.89)	0.78 (0.70, 0.87)	0.80 (0.75, 0.85)	0.91 (0.89, 0.94)

* As assessed at outpatient antenatal visits or medical assessment unit visits prior to the delivery admission. BP was categorized according to the 2017 ACC/AHA criteria as follows: normal (sBP <120 mmHg and dBP <80 mmHg), elevated (sBP 120–129 mmHg but dBP <80 mmHg), Stage 1 hypertension (sBP 130–139 mmHg and/or dBP 80–89 mmHg), and Stage 2 hypertension (sBP ≥140 mmHg and/or dBP ≥90 mmHg). Diagnostic test properties were calculated for the lower limit of each category and above, vs. BP values below the category. +LR was calculated as sensitivity/(1-specificity) and -LR as (1-sensitivity)/specificity.

ł Likelihood ratios were calculated for each category and above, vs. the category(ies) below.

ACC, American College of Cardiology; AHA, American Heart Association; BP, blood pressure; CI, confidence interval; FP, false positive; HTN, hypertension; LR, likelihood ratio; PPH, postpartum hemorrhage.

https://doi.org/10.1371/journal.pmed.1004471.t004

Analyses confined to BP readings obtained at 14–16 weeks' gestation yielded a comparable pattern of associations. Nevertheless, the diagnostic performance of all BP categories proved markedly limited at this early stage. Women exhibiting "Stage 2 hypertension" during this initial period faced substantially elevated risks of both preeclampsia and gestational hypertension (with or without preeclampsia).

Among a group of standard-risk nulliparous women, applying the 2017 ACC/AHA blood pressure cutoffs below the conventional 140/90 mmHg threshold (designated as "Stage 2 hypertension") during pregnancy would have resulted in an extra 35% of participants being identified as having abnormal blood pressure. Classification based on "Elevated BP" or "Stage 1 hypertension"—categories situated below the established "Stage 2 hypertension" cutoff of 140 mmHg systolic and/or 90 mmHg diastolic—failed to detect any heightened risk for postpartum hemorrhage (PPH), preterm birth (PTB), small-for-gestational-age (SGA) infants, or admission to the neonatal intensive care unit (NICU). Critically, these lower thresholds did not highlight women who faced greater chances of adverse pregnancy outcomes. Although "Stage 2 hypertension" correlated with elevated risks of PTB, SGA infants, and NICU admission, solely the severe form of "Stage 2 hypertension" proved useful for pinpointing women at risk of PTB who would already qualify for intensified care pathways. No specific blood pressure value emerged that could reliably offer reassurance concerning the likelihood of any examined outcome.

In the majority of clinical environments, a diagnosis of hypertension would classify a woman as "high risk," thereby constraining her options for antenatal care during the current pregnancy. Existing guidelines call for more intensive monitoring of both maternal and fetal health, which may include planned delivery at a specified time [28, 29]. Moreover, because hypertensive disorders of pregnancy can recur, management strategies in subsequent pregnancies could be adjusted, potentially incorporating preventive interventions [28]. Such reclassification as

high-risk is warranted solely when tangible benefits are evident; however, the results of this study imply that these benefits are absent.

Following the 2017 release of the ACC/AHA categories, a substantial body of research has explored their relevance in pregnant populations and links to unfavorable pregnancy results. Most investigations have centered on blood pressure readings taken prior to 20 weeks of gestation [12, 14, 16, 17, 30–35]. Systematic reviews conducted more recently have noted connections between adverse outcomes and both "Elevated BP" and "Stage 1 hypertension." Nevertheless, likelihood ratios demonstrate that the associated thresholds (120 mmHg systolic or 130/80 mmHg) exhibit limited accuracy in distinguishing women at higher or lower risk [36–38]. These observations have prompted the determination that, to our knowledge, sufficient grounds do not exist to reduce the blood pressure threshold defining normal values in pregnancy. Lowering the threshold would substantially expand the number of women assigned to high-risk pathways without clear evidence of improved pregnancy results.

Our earlier systematic reviews [13, 18, 39] on the 2017 ACC/AHA blood pressure categories included just three studies restricted to nulliparous women, two of which [13, 18] assessed blood pressure during the latter part of pregnancy. In nulliparous individuals, risk evaluation must proceed without the benefit of obstetric history. Because the highest blood pressure measurement in the current investigation occurred within the two weeks preceding delivery, the findings correspond most closely with data from the 33–36 week subgroups in mixed-parity cohorts [40]. In those subgroups (differing from our observations), "Elevated BP" and "Stage 1 hypertension" linked to greater risks of PTB and NICU admission. In line with the present analysis, however, "Stage 2 hypertension" related to increased occurrences of PTB, SGA infants, and NICU admission. Notably, in our cohort, none of the categories—"Elevated BP," "Stage 1 hypertension," or "Stage 2 hypertension"—effectively distinguished nulliparous women according to their risk level for these outcomes. Unlike the systematic review, our study also evaluated postpartum hemorrhage, which was not addressed in that earlier work.

The SCOPE study comprised a sizable, prospective, multinational cohort of nulliparous women. Trained research nurses obtained blood pressure readings with a validated instrument following a uniform protocol, which strengthens confidence in the accuracy of these data. As far as we are aware, this represents the initial evaluation of the 2017 ACC/AHA blood pressure categories both within this particular demographic and when applied as diagnostic standards in pregnancy.

One constraint of the present work is the relative ethnic uniformity of the SCOPE participants, which does not match the diversity of the source populations and therefore restricts broader applicability of the conclusions. Blood pressure data gathered during standardized SCOPE visits at 14–16 and 19–21 weeks adhered strictly to protocol. By comparison, late-pregnancy readings (within two weeks of birth) were derived from routine clinical documentation, so equivalent measurement rigor could not be guaranteed. For most women, these late-pregnancy values constituted their highest antenatal readings, meaning categorization relied predominantly on clinical records. While this enhances real-world relevance, it introduces the possibility of misclassification. Although we examined blood pressure values from the two weeks before delivery, further rises could have occurred afterward [38]. Only seven women (0.2%) who experienced intrapartum or postpartum preeclampsia maintained blood pressure below 140/90 mmHg across their entire pregnancy. The original SCOPE protocol recorded aspirin use solely at the first antenatal visit without later confirmation; given the low-risk profile of participants and the timing of recruitment relative to later evidence on aspirin for preterm birth prevention [41], it is reasonable to assume minimal use. Lastly, information was incomplete for some outcomes, including the distinction between iatrogenic and spontaneous PTB, an event that affected only a small proportion of participants.

These analyses within a nulliparous population emphasize the ongoing need for vigilant clinical observation in late pregnancy, since no blood pressure threshold could exclude the possibility of adverse outcomes. Incorporating blood pressure as a continuous measure in predictive models (such as those for preeclampsia [42]) may detect heightened risk below the 140/90 mmHg level. Additional characteristics, including blood pressure variability across visits, could also help recognize at-risk women suitable for enrollment in preventive trials, for example those involving aspirin [43]. When establishing diagnostic cutoffs, careful attention must be paid to the resource implications of expanded surveillance for women identified with pregnancy hypertension to ensure cost-effective care [44]. This issue holds particular significance in low- and middle-income settings, where the burden of hypertensive disorders of pregnancy and associated complications is greatest [45].

Conclusion

The present results demonstrate that, in nulliparous women as in the general pregnant population, the 2017 ACC/AHA blood pressure categories correlate with adverse pregnancy outcomes yet lack the capacity to meaningfully separate those pregnancies at elevated risk from those at lower risk. Consequently, this study does not endorse the application of the reduced 2017 ACC/AHA blood pressure thresholds during pregnancy in nulliparous women.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Scott G, Gillon TE, Pels A, von Dadelszen P, Magee LA. Guidelines-similarities and dissimilarities: a systematic review of international clinical practice guidelines for pregnancy hypertension. Am J Obstet Gynecol. 2020.
2. Magee LA, Brown MA, Hall DR, Gupte S, Hennessy A, Karumanchi SA, et al. The 2021 International Society for the Study of Hypertension in Pregnancy classification, diagnosis & management recommendations for international practice. Pregnancy Hypertens. 2022;27:148-69.
3. Duffy J, Cairns A, Richards-Doran D, van't Hooft J, Gale C, Brown M, et al. A core outcome set for pre-eclampsia research: an international consensus development study. BJOG. 2020;127(12):1516-26.
4. Al Khalaf SY, O'Reilly ÉJ, Barrett PM, Leite DFB, Pawley LC, McCarthy FP, et al. Impact of Chronic Hypertension and Antihypertensive Treatment on Adverse Perinatal Outcomes: Systematic Review and Meta-Analysis. JAMA. 2021;10(9):e018494.
5. Bramham K, Parnell B, Nelson-Piercy C, Seed PT, Poston L, Chappell LC. Chronic hypertension and pregnancy outcomes: systematic review and meta-analysis. BMJ. 2014;348:g2301.
6. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. Circulation. 2016;134(6):441-50.
7. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16(4):223-37.
8. Whelton PK, Carey RM, Aronow WS, Casey DE Jr., Collins KJ, Dennison Himmelfarb C, 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. JACC. 2018;71(19):e127-248.
9. Davey DA, MacGillivray I. The classification and definition of the hypertensive disorders of pregnancy. AJOG. 1988;158(4):892-8.
10. Stone P, Cook D, Hutton J, Purdie G, Murray H, Harcourt L. Measurements of Blood Pressure, Oedema and Proteinuria in a Pregnant Population of New Zealand. Aust N Z J Obstet Gynaecol. 1995;35(1):32-7.
11. Payne BA, Hutcheon JA, Ansermino JM, Hall DR, Bhutta ZA, Bhutta SZ, et al. A Risk Prediction Model for the Assessment and Triage of Women with Hypertensive Disorders of Pregnancy in Low-Resourced Settings: The mini PIERS (Pre-eclampsia Integrated Estimate of RiSk) Multi-country Prospective Cohort Study. PLoS Med. 2014;11(1):e1001589.
12. Greenberg VR, Silasi M, Lundsberg LS, Culhane JF, Reddy UM, Partridge C, et al. Perinatal outcomes in women with elevated blood pressure and stage 1 hypertension. AJOG. 2021;224(5):521.e1-11.
13. Hauspurg A, Sutton EF, Catov JM, Caritis SN. Aspirin Effect on Adverse Pregnancy Outcomes Associated With Stage 1 Hypertension in a High-Risk Cohort. Hypertension. 2018;72(1):202-7.

14. Hu J, Li Y, Zhang B, Zheng T, Li J, Peng Y, et al. Impact of the 2017 ACC/AHA Guideline for High Blood Pressure on Evaluating Gestational Hypertension-Associated Risks for Newborns and Mothers. Circ Res. 2019;125(2):184-94.
15. Li Q, Zheng L, Gu Y, Jiang D, Wang G, Li J, et al. Early pregnancy stage 1 hypertension and high mean arterial pressure increased risk of adverse pregnancy outcomes in Shanghai, China. J Hum Hypertens. 2021.
16. Sutton EF, Rogan SC, Lopa S, Sharbaugh D, Muldoon MF, Catov JM. Early Pregnancy Blood Pressure Elevations and Risk for Maternal and Neonatal Morbidity. Obstet Gynecol. 2020;136(1):129-39.
17. Hauspurg A, Parry S, Mercer BM, Grobman W, Hatfield T, Silver RM, et al. Blood pressure trajectory and category and risk of hypertensive disorders of pregnancy in nulliparous women. AJOG. 2019;221(3):277.e1-8.
18. Sutton EF, Hauspurg A, Caritis SN, Powers RW, Catov JM. Maternal Outcomes Associated With Lower Range Stage 1 Hypertension. Obstet Gynecol. 2018;132(4):843-9.
19. Sisti G, Colombi I. New blood pressure cut off for preeclampsia definition: 130/80 mmHg. Eur J Obstet Gynecol Reprod Biol. 2019;240:322-4.
20. McGowan L, North RA, Taylor R. Screening for pregnancy endpoints: preeclampsia, growth restricted baby and spontaneous preterm birth [Internet]. Australian New Zealand Clinical Trials Registry; 2007 [cited 2024 Aug 26]. Available from: https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=82254
21. McCowan LME, Thompson JMD, Taylor RS, Baker PN, North RA, Poston L, et al. Prediction of Small for Gestational Age Infants in Healthy Nulliparous Women Using Clinical and Ultrasound Risk Factors Combined with Early Pregnancy Biomarkers. PLoS ONE. 2017;12(1):e0169311.
22. Whelton PK, Carey RM, Aronow WS, Casey DE Jr., Collins KJ, Dennison Himmelfarb C, 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(6):e13-115
23. McCowan L, Stewart AW, Francis A, Gardosi J. A customised birthweight centile calculator developed for a New Zealand population. Aust N Z J Obstet Gynaecol. 2004;44(5):428-31.
24. Gardosi J, Clausson B, Francis A. The use of customised versus population-based birthweight standards in predicting perinatal mortality. BJOG. 2007;114(10):1301-2.
25. Zou G. A modified poisson regression approach to prospective studies with binary data. Am J Epidemiol. 2004;159(7):702-6.
26. Deeks JJ, Altman DG. Diagnostic tests 4: likelihood ratios. BMJ. 2004;329(7458):168-9.
27. Jaeschke R, Guyatt GH, Sackett DL. Users' guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will they help me in caring for my patients? The Evidence-Based Medicine Working Group. JAMA. 1994;271(9):703-7.
28. Macdonald-Wallis C, Lawlor DA, Fraser A, May M, Nelson SM, Tilling K. Blood pressure change in normotensive, gestational hypertensive, preeclamptic, and essential hypertensive pregnancies. Hypertension. 2012;59(6):1241-8.
29. National Institute for Health and Care Excellence: Guidelines. Hypertension in pregnancy: diagnosis and management. London: National Institute for Health and Care Excellence (NICE). NICE 2019; 2019.
30. ACOG Practice Bulletin No. 203: Chronic Hypertension in Pregnancy. Obstet Gynecol. 2019;133(1):e26-50.
31. Darwin KC, Federspiel JJ, Schuh BL, Baschat AA, Vaught AJ. ACC-AHA Diagnostic Criteria for Hypertension in Pregnancy Identifies Patients at Intermediate Risk of Adverse Outcomes. Am J Perinatol. 2021;38:e249-55.
32. Duffy JY, Getahun D, Chen Q, Fong A. Pregnancy Outcomes Associated With a Single Elevated Blood Pressure Before 20 Weeks of Gestation. Obstet Gynecol. 2021;138(1):42-50.
33. McLaren RA, Atallah F, Persad VVD, Narayanamoorthy S, Gougol N, Silver M, et al. Pregnancy outcomes among women with American College of Cardiology- American Heart Association defined hypertension. J Matern Fetal Neonatal Med. 2019:1-6.
34. Nagao T, Saito K, Yamanaka M. Prehypertension in early pregnancy is a risk factor for hypertensive disorders during pregnancy: A historical cohort study in Japan. Hypertens Pregnancy. 2021;40(1):51-5.
35. Sabol BA, Porcelli B, Diveley E, Meyenburg K, Woolfolk C, Raghuraman N, et al. Defining the risk profile of women with stage 1 hypertension: a time to event analysis. AJOG MFM. 2021;3(4):100376.

36. Tesfalul MA, Sperling JD, Blat C, Parikh NI, Gonzalez-Velez JM, Zlatnik MG, et al. Perinatal outcomes and 2017 ACC/AHA blood pressure categories. Pregnancy Hypertens. 2022;28:134-8.
37. Slade LJ, Mistry HD, Bone JN, Wilson M, Blackman M, Syeda N, et al. American College of Cardiology/American Heart Association blood pressure categories—a systematic review of the relationship with adverse pregnancy outcomes. AJOG. 2023;229(4):418-29.e34.
38. Slade L, Wilson M, Mistry H, Bone J, Bello N, Blackman M, et al. The 2017 American College of Cardiology/American Heart Association blood pressure categories in the second half of pregnancy–a systematic review of their association with adverse pregnancy outcomes. AJOG. 2023;229(2):101-17.
39. Xiao Y, Liu J, Teng H, Ge W, Han B, Yin J. Stage 1 hypertension defined by the 2017 ACC/AHA guidelines and neonatal outcomes: Systematic review and meta-analysis. Pregnancy Hypertens. 2021;25:204-12.
40. He D, Wu S, Zhao H, Zheng Z, Zhang W. High normal blood pressure in early pregnancy also contribute to early onset preeclampsia and severe preeclampsia. Clin Exp Hypertens. 2018;40(6):539-46.
41. Hoffman MK, Goudar SS, Kodkany BS, Metgud M, Somannavar M, Okitawutshu J, et al. Low-dose aspirin for the prevention of preterm delivery in nulliparous women with a singleton pregnancy (ASPIRIN): a randomised, double-blind, placebo-controlled trial. Lancet. 2020;395(10220):285-93.
42. Tan MY, Wright D, Syngelaki A, Akolekar R, Cicero S, Janga D, et al. Comparison of diagnostic accuracy of early screening for pre-eclampsia by NICE guidelines and a method combining maternal factors and biomarkers: results of SPREE. Ultrasound Obstet Gynecol. 2018;51(6):743-50.
43. Wilson MG, Bone JN, Slade LJ, Mistry HD, Singer J, Crozier SR, et al. Blood pressure measurement and adverse pregnancy outcomes: A cohort study testing blood pressure variability and alternatives to 140/90 mmHg. BJOG. 2023.
44. Cluver C, Tong S. Revisiting blood pressure thresholds to define hypertension during pregnancy: is 140/90 mmHg too high? Lancet Glob Health. 2021;9(8):e1041-2.
45. Bone JN, Magee LA, Singer J, Nathan H, Qureshi RN, Sacoor C, et al. Blood pressure thresholds in pregnancy for identifying maternal and infant risk: a secondary analysis of Community-Level Interventions for Pre-eclampsia (CLIP) trial data. Lancet Glob Health. 2021;9(8):e1119-28.