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Health, Physical Growth, and Neurodevelopmental Outcomes in Preterm Infants of Women with Hypertensive Disorders of Pregnancy

Forgive Avorgbedor, PhD, RN [postdoctoral associate],

School of Medicine, Duke University at Durham, North Carolina.

Susan Silva, PhD [associate research professor],

School of Nursing and School of Medicine, Duke University at, Durham, North Carolina.

Elizabeth Merwin, PhD, RN, FAAN [professor and executive, vice-dean],

School of Nursing, Duke University at Durham, North Carolina.

James A. Blumenthal [professor], and

School of Medicine, Duke University at Durham, North Carolina

Diane Holditch-Davis, PhD, RN, FAAN [professor emerita]

School of Nursing, Duke University at Durham, North, Carolina.

Abstract

Objective: To compare the health, physical growth, and developmental outcomes in preterm infants of women with and without hypertensive disorders of pregnancy (HDP).

Design: Cross-sectional analysis of health outcomes; physical growth (head circumference, height, and weight) collected at birth and 2 months corrected for prematurity; and cognitive, language, and motor skills of preterm infants of women with and without HDP.

Setting: Four NICUs in the United States.

Participants: Women ($n=221$) and their preterm infants who weighed less than 1750g were enrolled in a multicenter, randomized trial of two interventions administered by the infant's mother when the infants were no longer critically ill.

Methods: Women and their preterm infants were categorized into groups with ($n=80$) and without (control, $n=141$) HDP. Data were extracted from infant medical records, and the women completed questionnaires.

Correspondence: Forgive Avorgbedor, PhD, RN, Duke University Medical Center, Department of Psychiatry and Behavioral Sciences, DUMC Box 3119, Durham, NC 27710, Forgive.avorgbedor@duke.edu.

Disclosure

The authors report no conflict of interest or relevant financial relationships

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Results: The infants of women with HDP were more likely to be small for gestational age than the infants of women without HDP (31.7% versus 10.6%, $p<0.002$). The proportion of infants with high neurological risk, patent ductus arteriosus, intraventricular hemorrhage, and days on a ventilator did not differ between the groups. Although infants' height at 2 months was lower in the HDP group than the control group, other growth and neurodevelopmental outcomes did not differ between the groups.

Conclusion: Among preterm infants admitted to the NICU, those born to women with HDP were more likely to be small for gestational age than those of normotensive women. Additional research is needed to optimize care for infants born to women with HDP.

Precis

Preterm infants of women with hypertensive disorders of pregnancy were more likely to be small for gestational age but developed at rates similar to preterm infants of normotensive women

Keywords

Preterm infants; Hypertensive disorders of pregnancy; small for gestational age

Hypertensive disorders of pregnancy (HDP) occur in 5 to 10% of pregnancies (Lo, Mission, & Caughey, 2013). These disorders, including chronic hypertension and pregnancy-induced hypertension (gestational hypertension and preeclampsia/eclampsia), frequently result in high rates of infant mortality (American College of Obstetricians and Gynecologists [ACOG], 2013). Pregnant women with HDP experience more severe obstetric and perinatal complications than women without HDP, including higher risk for stillbirth (Barbosa et al., 2015; Hutcheon, Lisonkova, & Joseph, 2011), twice the risk for preterm birth (PTB) (Broekhuijsen et al., 2015; Ferrazzani et al., 2011; Hutcheon, Lisonkova, & Joseph, 2011), 3–4 times the risk for small for gestational age (SGA) infants (Ferrazzani et al., 2011; Hutcheon, Lisonkova, & Joseph, 2011), and increased risk that their infants will be admitted to NICUs (Broekhuijsen et al., 2015).

In 2016, the prevalence of PTB in the United States was 9.8% (Martin, Hamilton, & Osterman, 2017), and most cases of iatrogenic preterm birth were caused by HDP (Hutcheon, Lisonkova, & Joseph, 2011). Preterm infants (born before 37 weeks gestation) are at increased risk for medical complications including morbidity and severe respiratory problems because of immature organ systems, severe intraventricular hemorrhage (IVH), and neurodevelopmental dysfunction and are more likely to experience spontaneous patent ductus arteriosus (PDA) closure (Stoll et al., 2010; Myers & Ment, 2009). Preterm newborns are more likely to be unable to effectively regulate body temperature, have low blood sugar, and have increased red blood cells, which may impair development (Stoll et al., 2010). About half of preterm infants experience PDA and IVH, which leads to adverse neurodevelopment and even death, particularly after early-onset IVH (Lu, Wang, Lu, Zhang, & Kumar, 2016; Myers & Ment, 2009; Stoll et al., 2010). Moreover, preterm infants are at greater risk for long-term lung diseases and neurodevelopmental disabilities that affect cognitive and motor skills into adolescence and adulthood (Myers & Ment, 2009).

Preterm birth is twice as common in infants of women with HDP than in infants of women without HDP (Bramham et al., 2014; Cruz, Gao, & Hibbard, 2011; Kuklina, Ayala, & Callaghan, 2009). The infants of women with HDP are approximately 3 times more likely to be admitted to NICUs than preterm and full term infants born to normotensive women (Broekhuijsen et al., 2015; Madi et al., 2012; Savitz et al., 2014), and term and preterm infants of women with HDP are at increased risk for cognitive dysfunction (Pinheiro, Brunetto, Ramos, Bernardi, & Goldani, 2016). Evidence suggests that preterm and full term infants born to women with HDP are at increased risk for impaired language development, neurocognitive dysfunction, and impaired neurobehavioral development compared to infants without exposure to HDP (Adams-Chapman et al., 2013; Nomura et al., 2017; Pinheiro et al., 2016).

In one recent study, preterm infants who were SGA were more often born to women with HDP than preterm infants who were not SGA (Jensen et al., 2018). In comparison to full term infants born SGA, preterm infants who are SGA at birth are at greater risk for bronchopulmonary dysplasia, which may require ventilator use and lead to impaired neurodevelopment (Jensen et al., 2018; Nobile, Marchionni, & Carnielli, 2017). Although some evidence indicates increased morbidity and developmental impairment in all infants exposed to HDP, the effect of maternal hypertension on the health and development of preterm infants compared to preterm infants of normotensive mothers has not been widely studied.

Therefore, the purpose of our study was to examine the short-term health outcomes of preterm infants born to women with and without HDP. We hypothesized that preterm infants born to women with HDP would have worse health, growth, and developmental outcomes than preterm infants born to women who were normotensive during pregnancy. The variables selected for this study were based on the literature on the complications associated with HDP (Bramham et al., 2014; Katz et al., 2013; Kuklina, Ayala, & Callaghan, 2009; Nomura et al., 2017; Pinheiro et al., 2016)

Methods

Design and Settings

We conducted a secondary analysis of data from a randomized controlled trial (RCT) of preterm infants and their mothers in which researchers tested two interventions administered by the infant's mother (Holditch-Davis et al., 2014). The purpose of the parent study was to examine the effects of the auditory-tactile-visual-vestibular intervention and kangaroo care on maternal distress and the mother-infant relationship (Holditch-Davis et al., 2014). In this secondary analysis, we compared preterm infants born to women with HDP to preterm infants born to women without HDP (control). In the parent study, which was conducted from 2006–2011, researchers examined the effects of the auditory-tactile-visual-vestibular intervention and kangaroo care on maternal distress and the mother-infant relationship with both intervention groups compared to an attention control group in four hospitals: two in North Carolina and two in Illinois. The hospitals in North Carolina served urban, suburban, and rural people of diverse socioeconomic status whereas the hospitals in Illinois served

inner city and poor populations. The study was approved by the Duke University Health System Institutional Review Board.

Participants

For the parent study, women and their preterm infants who weighed less than 1750g at birth (singleton or multiple births but only one infant from each multiple birth set was included in the original study) were enrolled. Infants who had prenatal exposure to substances with symptoms or who experienced congenital neurological problems were excluded from the study. All women were eligible except for women who could not participate in follow-up for 12 months, had histories of psychosis or bipolar disease, had major depression at the time of enrollment, or did not speak English.

Our analysis included data for preterm infants and their mothers at baseline, 2 months, and 12 months corrected for prematurity. The parent study had a total sample of 240 dyads. The total sample for this analysis was 221 women who had data on HDP and their infants (19 were excluded from this analysis because data on HDP was not available), with 80 dyads (36%) in the HDP group and 141 (64%) in the control group. Among the 36% of women with HDP, 14 (17.5%) had chronic hypertension, 43 (53.8%) had pregnancy induced hypertension (PIH), and 23 (28.8%) had chronic hypertension and PIH. Infants who were hospitalized longer than 1 month past term were withdrawn from the sample. Other infants were lost to follow-up. At 2 months, data from 161 infants were available for analysis, and at 12 months, data from 155 were available for analysis.

Measures

Data were collected from the medical records of the study participants, including demographics, the presence of maternal hypertension, complications in pregnancy, complications in preterm infants, and preterm infants' use of mechanical ventilators. Data were collected and abstracted by trained research assistants (RAs) who were nurses. The RAs received 20 hours of training from the study investigators on study goals and design and were supervised through weekly phone calls. To ensure data accuracy, data were entered twice by RAs and initial data collection was done jointly by the investigators and the RAs (Holditch-Davis et al., 2014).

HDP status.—The two-group, independent variable for our study was the presence of HDP, which was a measure of a maternal history of chronic hypertension and/or pregnancy-induced hypertension (gestational hypertension or preeclampsia during pregnancy).

Infant health outcomes.—Small for gestational age (defined as an estimated infant birth weight less than the 10th percentile for gestational age), PDA, IVH, and number of days of mechanical ventilator use were obtained from the infants' medical records. Infant neurological risk was measured using the Neurobiological Risk Scale (NBRS; Brazy, Goldstein, Oehler, Gustafson, & Thompson, 1993) with item data obtained from infants' medical records. The items in the NBRS (blood pH, presence of seizures, IVH, periventricular leukomalacia, infections, mechanical ventilation, and hypoglycemia) were scored by RAs on a 4-point scale and used to determine the possible severity of insults to the

brain through direct injury or inadequate blood flow, oxygenation, or nutrients. Seven neurological insults were scored, and higher scores indicated more severe insults. Total scores of greater than or equal to 4 were considered low risk, scores of 5 to 7 were considered intermediate risk, and scores of 8 to 28 were considered high risk for abnormal neurological outcomes (Brazy et al., 1993). Cronbach's alpha coefficient in this sample was 0.71 (Holditch-Davis et al., 2014).

Infant physical growth outcomes.—The physical growth variables included head circumference in centimeters (cm), height in cm, and weight in grams. These three indicators of infant growth were assessed at birth and 2 months corrected for prematurity.

Infant neurodevelopmental outcomes.—The Bayley Scales of Infant and Toddler Development (BSID-III; Bayley, 2003) were used as a standardized developmental assessment to measure three components of infant development at 12 months: cognitive, language, and motor skills. A psychologist who was unaware of the infant's group assignment administered the BSID-III at the neonatal follow-up clinic or occasionally at the infant's home. The BSID-III is a standardized, norm-referenced measure and a child's performance is compared with normative data from children of the same age (Bayley, 2003). Reported reliability estimates for the BSID-III range from 0.91–0.93 (Albers & Grieve, 2007). The standardized composite scores for each of the three domains were analyzed. Standard scores have a mean of 100 and a standard deviation of 15, with a higher score representing better performance.

Procedure

For the parent study, women and their preterm infants were recruited at the NICUs when infants were no longer ill and weighed at least 1000 grams. Infants were withdrawn from the study if they remained hospitalized longer than 1 month after term gestation. Women provided informed consent, and baseline questionnaires were administered. Data were also collected at hospital discharge, and at 2 months and 6 months corrected for prematurity by nurses and assessment team members.

Data Analysis

Analyses were conducted using SAS Version 9.4 (SAS Institute Inc. Cary, NC). Descriptive statistics were used to describe maternal and infant characteristics for the total sample and for the HDP and control groups. We conducted bivariate and multivariate logistic regression models to test for between-group differences in the dichotomized (1,0) infant health outcomes, namely neurological risk (NBRS score ≤ 4 are considered low risk=0 score, > 4 are considered intermediate/high risk=1), PDA, IVH, and SGA. Odds ratios (OR) and eta-squared (η^2) values along with their 95% confidence interval (CI) were calculated to address effect size and clinical significance. We tested non-directional hypotheses with the level of significance set at 0.05.

For all continuous outcome variables, we used general linear models. Because the data distribution was severely skewed, the natural log of the number days on ventilation days +1 was derived to normalize the data for inclusion in the analytic models. For physical growth

outcomes, we examined infant head circumference, height, and weight at both birth and 2 months. Finally, we examined neurodevelopmental outcomes by assessing group differences in cognitive, language, and motor skills. Within each set of analyses, we first examined the unadjusted associations between each predictor and outcome and then fit a multivariate model using an iterative backward variable elimination method.

Covariates.—Because of significant differences between the HDP and the control groups on maternal race, maternal history of diabetes, and the presence of multiple births, these variables were adjusted for in the analyses. To minimize any possible intervention effects, the parent study's intervention group was examined as a covariate for variables collected after group assignment including physical growth and neurodevelopment.

Results

Sample Characteristics

The sample included mostly Black women and their infants. The HDP group had a significantly higher proportion of Black women than the control group ($\chi^2=4.877$; $df=1$, $p=0.027$; Table 1). Approximately 18% of the sample were mothers with multiple births, and the percentage of multiple births was significantly lower in the HDP group than in the control group ($\chi^2=5.046$; $df=1$, $p=0.025$). Seventeen women (8%) had a history of diabetes (before or during pregnancy) and they were more likely to be in the HDP group. Table 1 presents the characteristics of the infants for the total sample and for each group. There were no significant between groups differences for these infant characteristics.

Infant Medical Outcomes

Table 2 presents logistic regression and general linear model results for infant health outcomes between the two groups. The bivariate and multivariate results revealed no significant group differences on neurological risk, PDA, IVH and days on mechanical ventilation, except that the HDP group had a higher percentage of SGA infants (31.7% versus 10.6%, $p=0.002$), and estimated odds were almost four times higher than the control group without HDP. In addition, the infants of women with HDP tended to have lower neurological and IVH event rates compared to infants of women in the control group (neurological risk 28.8% versus 40.7%, $p<0.08$; IVH 26.3% versus 37.9%, $p<0.08$).

After controlling for the covariates, race (Black, non-Black) was a statistically significant covariate for ventilator days and neurological risk; infants of Black women had lower mean numbers of days on the ventilator (log mean $\pm$ SD Black, 1.8 ± 1.4 ; non-Black, 2.5 ± 1.4 , $p<0.001$) and lower rates of elevated neurological risk (Black, 29.1% versus non-Black, 52.2%, $p=0.002$) compared to infants of non-Black women.

Infant Physical Growth Outcomes

Descriptive statistics for infants' physical growth outcomes at birth and 2 months indicated that the mean infant height at 2 months tended to be less in the HDP group (mean $\pm$ SD; 55.6 ± 3.8) relative to the control group (mean $\pm$ SD; 56.9 ± 4.4) for the total sample and for the

infants who had data at both assessment points but these differences were not significant (see Table 3).

Table 4 presents the analysis of covariance procedures using general linear model for each 2 month outcome, controlling for the same measure at birth and other potential covariates. Analyses were conducted on the infants with data at both time points. None of the other potential covariates significantly influenced the 2 month outcomes and, therefore, they were omitted from the final models. The results indicated that the mean infant height at 2 months was lower in the HDP group than the control group after controlling for height at birth ($\eta^2_{\text{partial}}=0.022$, representing a small effect), but the difference was not significant. Greater height at birth was a significant predictor of greater height at 2 months.

Infant Neurodevelopmental Outcomes

The HDP and control groups did not differ significantly on the infant neurodevelopmental outcomes with or without covariates at 12 months (see Tables 3 and 4). Covariates were not significantly associated with any of the outcomes. Thus, the final models included only HDP status. As shown in Table 4, HDP was not related to any of neurodevelopmental outcomes.

Discussion

In this secondary analysis, we compared differences between preterm infants of women with and without a histories of hypertension in pregnancy on health, physical growth, and neurodevelopmental outcomes. The preterm infants of women with HDP were very similar to preterm infants of women without histories of HDP on most health, growth, and developmental outcomes, except for the higher rate of SGA in the infants of women with HDP. The two groups of infants did not differ on health outcomes after birth. Also, there was no difference in the infants born to women with HDP and normotensive women on a number of neurodevelopmental outcomes including cognitive, language, and motor skills at 12 months corrected for prematurity.

The only difference observed between women with and without HDP was that preterm infants born to women with HDP were more likely to be SGA than preterm infants of women without HDP. A higher risk for SGA infants among women with HDP is consistent with findings from a previous study of women and their full term and preterm infants (Jensen et al., 2018). Yet even among preterm infants admitted to NICUs, HDP had a significant effect on the rate of SGA in the preterm infants. Preterm infants included in this study weighed less than 1750g and were ill at birth. We found that HDP was a complicating factor. In comparison to SGA infants born full-term, preterm infants born SGA have complications associated with immature organ systems including poor body temperature regulation, low blood sugar, and increased red blood cells, which can impair development (Stoll et al., 2010). Thus, a maternal history of HDP that affected size for gestational age and weight of preterm infants admitted to NICUs at birth is a significant finding. This finding that requires the attention of health care providers and researchers to identify and provide specialized intervention for these vulnerable preterm infants.

Despite a lack of other significant findings, preterm infants born SGA have complications such as bronchopulmonary dysplasia and IVH that increase the use of ventilators and prolong hospitalization compared to infants born at appropriate for gestational age (Jackson, Needelman, Roberts, Willet, & McMorris, 2012; Jensen et al., 2018; Nobile et al., 2017; Nomura et al., 2017). Recognizing that preterm infants of women with HDP may be SGA may improve care and early intervention for all preterm infants including those who did not meet NICU admission requirements. Preterm SGA infants have higher mortality rates than term SGA infants (Katz et al., 2013). In comparison to term appropriate for gestational age infants, preterm SGA infants have 10 to 40 times the risk for dying in the first month of life (Katz et al., 2013). The risks of short- and long-term health complications associated with being born preterm and SGA are greater than preterm or SGA alone (Katz et al., 2013; Nobile et al., 2017). Thus, the potential effects HDP has on preterm SGA infants indicate the need for early intervention.

The infants of women with and without HDP in this study did not differ on health complications. Previously, Cruz and colleagues reported that women with histories of HDP had infants who required more days of mechanical ventilation compared to infants of normotensive mothers (Cruz et al., 2011). The need for ventilators for infants of women with and without HDP may be similar in the present study because our sample only included preterm infants recruited from NICUs whereas Cruz and colleagues (2011) included all births (preterm and full term) in their study.

Although, we did not find a statistically significant difference between groups related to developmental delays, the mean scores for physical growth were slightly lower in the HDP group compared to the control group. In addition, strong evidence suggests that preterm infants who spend more than 48 hours in the NICUs are at greater risk for developmental delays, especially in gross motor skills and language, than preterm infants without NICU admission and full-term infants (Adams-Chapman et al., 2013; Jackson, Needelman, Roberts, Willet, & McMorris, 2012; Myers & Ment, 2009).

The lack of significant differences between the preterm infants of women with and without HDP related to physical growth and neurodevelopment suggest that despite a higher risk of SGA, the preterm infants of women with HDP developed and grew at similar rates as infants of women without HDP. Cognitive, language, and motor development by 12 months corrected age and growth measures at 2 months of infants of women with and without HDP also were similar. Therefore, maternal history of HDP did not appear to contribute significantly to the physical growth and neurodevelopmental observations among preterm infants treated in NICUs in our sample.

Limitations

Our study was limited because preterm infants in this study belonged to a select group in which preterm infants who died and preterm infants who did not require NICU admission were not included. Thus, the results may not be representative of all preterm infants. Also, attrition due to infant death, loss to follow-up, and lack of HDP data on some of the participants from the parent study may limit interpretation of the findings because missing data might have affected the results. Due to a small sample size and unequal sample sizes

between the HDP group and the control group, the results should be interpreted with caution.

Conclusion

We found that the preterm infants born to women with histories of HDP were more often SGA than the preterm infants of women without HDP. However, compared to infants of women with normal blood pressure, there were no infant health, physical health, or neurodevelopmental differences or outcomes in infants born to women with HDP. Our findings suggest that preterm infants of women with HDP will likely grow at the same rate as other preterm infants during their first 2 months of life. Finally, because women with HDP are more likely to have preterm infants than normotensive women and because these preterm infants are more likely to be SGA at birth, neonatal clinicians need to be aware that preterm infants of women with HDP may require greater medical attention to optimize their long-term health.

The rate of preterm birth continues to increase, and preterm infants now survive at higher rates than in the past. At the same time, women are giving birth later in life, which potentially predisposes fetuses to exposure to hypertension. Our findings suggest the need for further studies on appropriate interventions for all newborns exposed to maternal hypertension whether they are born preterm or at term.

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Callouts:

1. Preterm infants of women with hypertensive disorders of pregnancy admitted to NICUs may have more severe morbidity than preterm infants of normotensive women.
2. Although more likely to be small for gestational age, preterm infants of women with-hypertensive disorders of pregnancy developed similarly to infants of normotensive women.
3. Because of the complications associated with being small for gestational age at birth, preterm infants of women with hypertensive disorders of pregnancy require increased surveillance.

Table 1.

Descriptive Statistics for the Characteristics of the Preterm Infants and Their Mothers and Comparison of the Two Groups

Characteristic	Total N= 221	Control N= 141	HDP N = 80
Race, <i>n</i> (%) *			
White	45 (20.4)	34 (24.1)	11 (13.8)
African-American	151 (68.3)	89 (63.1)	62 (77.5)
Hispanic	18 (8.1)	14 (9.9)	4 (5.0)
Other	7 (3.2)	4 (2.8)	3 (3.8)
Multiple Births, <i>n</i> (%) *	39 (17.7)	31 (22.0)	8 (10.0)
First-time mothers	120 (56.6)	74 (54.8)	46 (59.7)
Age, mean $\pm$ SD, yr.	27.4 $\pm$ 6.1	27.13 $\pm$ 5.9	27.73 $\pm$ 6.6
Education, mean $\pm$ SD, yr.	13.4 $\pm$ 2.3	13.5 $\pm$ 2.4	13.4 $\pm$ 2.1
Married, <i>n</i> (%)	70 (32.6)	43 (31.6)	27 (34.2)
Infertility, <i>n</i> (%)	9 (4.1)	7 (5.0)	2 (2.5)
History of diabetes, <i>n</i> (%) *	17 (8.0)	5 (3.6)	12 (16.2)
Prenatal care, <i>n</i> (%)	204 (92.7)	130 (92.2)	74 (93.7)
Gestational age at birth, weeks Mean (SD)	27.2 (2.9)	27.0 (2.9)	27.7 (2.9)
Birth weight, mean $\pm$ SD, g	1009.3 $\pm$ 331.3	1031.2 $\pm$ 332.2	970.9 $\pm$ 328.3
Female gender, <i>n</i> (%)	121 (54.8)	78 (55.3)	43 (53.8)
Infection <i>n</i> (%)	168 (76.4)	107 (76.4)	61 (76.3)
Infant surgery, <i>n</i> (%)	80 (36.5)	54 (38.9)	26 (32.5)
Necrotizing enterocolitis, <i>n</i> (%)	33 (15.1)	16 (13.7)	14 (17.5)

Note. Control=women without hypertensive disorders of pregnancy; HDP=women with hypertensive disorders of pregnancy; *t*-tests for continuous variables and chi-square tests for categorical variables; p-value is for a 2 $\times$ 2 chi-square test with the group (HDP vs Control) by race (Black vs non-Black).

*
p<.05

Table 2.
Logistic Regression and General Linear Model for Infant Medical Outcomes

Logistic Regression Model Outcome	Model	Explanatory Variable	Wald χ^2 (df=1)	P	OR	OR 95% CI
Neurological risk	Bivariate	HDP status	3.120	0.08	0.59	0.33, 1.06
	Multivariate	HDP status	1.818	0.18	0.66	0.36, 1.21
		Black	9.246	0.002	0.40	0.22, 0.72
PDA	Bivariate	HDP status	0.491	0.48	0.82	0.47, 1.43
SGA	Bivariate	HDP status	13.856	0.002	3.89	1.90, 7.95
IVH	Bivariate	HDP status	3.041	0.08	0.58	0.32, 1.07
General Linear Model	Model	Explanatory Variable	F _{df,df}	P	Partial η^2	Partial η^2 95% CI
Log of days on a ventilator	Bivariate	HDP status	0.81 _{1,219}	0.37	0.004	0.00, 0.04
	Multivariate	HDP status	0.16 _{1,218}	0.69	<.001	0.00, 0.02
		Black	11.70 _{1,218}	<.001	0.05	0.00, 0.12

Note. OR= odds ratio for outcome comparing HDP/control; Partial η^2 = partial eta-squared; 95% CI = 95% Confidence Interval; Model=bivariate model with group only or multivariate model with group and any significant covariates. GLM Type III sums of squares results. HDP= hypertensive disorders of pregnancy; NR=neurological risk; PDA=patent ductus arteriosus; SGA= small for gestational age; IVH=intraventricular hemorrhage.

Table 3.

Descriptive Statistics for Physical Growth and Neurodevelopmental Outcomes

Measures	Total	Control	HDP	<i>p</i>
Head circumference (<i>n</i>)	149	96	53	
Birth: Mean (SD)	28.5 (2.3)	28.4 (2.5)	28.8 (1.9)	0.289
Month 2: Mean (SD)	39.4 (2.1)	39.5 (2.0)	39.2 (2.2)	0.383
Height (<i>n</i>)	139	88	51	
Birth: Mean (SD)	40.0 (3.1)	40.0 (3.2)	40.0 (2.9)	0.993
Month 2: Mean (SD)	56.4 (4.3)	56.9 (4.4)	55.6 (3.8)	0.085
Weight (<i>n</i>)	161	104	57	
Birth: Mean (SD)	1.5 (0.4)	1.5 (0.4)	1.5 (0.4)	0.722
Month 2: Mean (SD)	5.0 (1.0)	5.1 (1.0)	4.9 (1.0)	0.256
Cognitive <i>n</i> at 12 months	155	99	56	0.265
Mean (SD)	97.3 (16.5)	96.2 (17.1)	99.3 (15.4)	
Language <i>n</i> at 12 months	153	97	56	0.314
Mean (SD)	90.8 (14.9)	89.9 (14.9)	92.4 (14.8)	
Motor skills <i>n</i> at 12 months	154	98	56	0.907
Mean (SD)	89.8 (17.8)	89.7 (17.6)	90.1 (18.4)	

Note: Only infants with data available at both birth and 2 months were analyzed; *p*-value for *t*-test; HDP= hypertensive disorders of pregnancy; SD= standard deviation. Running Head: Birth Outcomes in Hypertensive Women

Table 4.**Physical Growth and Neurodevelopmental Outcomes of Preterm Infants**

Physical Growth at 2 months	Explanatory Variable	F _{df, df}	p	Partial η^2	Partial η^2 95% CI
Head Circumference (HC)	HDP status	0.83 _{1,146}	0.37	0.01	0.00, 0.05
	HC at birth	0.22 _{1,146}	0.64	0.02	0.00, 0.04
Height (HT)	HDP status	3.09 _{1,136}	0.08	0.02	0.00, 0.09
	HT at birth	4.13 _{1,136}	0.04	0.03	0.00, 0.10
Weight (WT)	HDP status	1.28 _{1,158}	0.26	0.01	0.00, 0.06
	WT at birth	0.02 _{1,158}	0.89	0.01	0.00, 0.02
Neurodevelopmental at 12 Months	Explanatory Variable	F _{df, df}	p	Partial η^2	Partial η^2 95% CI
Cognitive	HDP status	1.25 _{1,153}	0.27	0.01	0.00, 0.06
Language	HDP status	1.02 _{1,151}	0.31	0.01	0.00, 0.06
Motor skills	HDP status	0.01 _{1,152}	0.91	<.001	0.00, 0.02

Note. Partial η^2 = partial eta-squared; CI = confidence interval; HDP = hypertensive disorders of pregnancy. Analysis of covariance using a General Linear Model approach for infants with data available.