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Pregnancy-Associated Hypertension and Offspring Cardiometabolic Health

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Abstract

Objective—To evaluate whether pregnancy-associated hypertension (gestational hypertension and preeclampsia) was associated with the cardiometabolic health of young offspring.

Methods—This was a prospective observational follow-up study from 2012 to 2013 of children born to women previously enrolled in a mild gestational diabetes mellitus (GDM) treatment trial or non-GDM observational study. At 5-10 years after birth, children were examined and fasting blood samples obtained to determine the following cardiometabolic risk factors: blood pressure, high-density lipoprotein cholesterol, triglycerides, glucose, homeostatic model assessment of insulin resistance, waist circumference, and body mass index.

Results—This analysis included 979 children evaluated at a median 7 years of age. Twenty-three (2%) were born preterm from a hypertensive pregnancy, 73 (7%) were born at term from a hypertensive pregnancy, 58 (6%) were born preterm from a normotensive pregnancy, and 825 (84%) were born at term from a normotensive pregnancy (reference group). After adjusting for confounding factors, mean adjusted systolic blood pressure was significantly higher in the children who were born at term to mothers who experienced pregnancy-associated hypertension compared with those born at term to normotensive mothers (systolic blood pressure of 104 mmHg, 95% CI 101-106 vs. systolic blood pressure of 99 mmHg, 95% CI 99-100, $p=.001$). No other significant differences were observed.

Conclusion—Pregnancy-associated hypertension in women who deliver at term was associated with higher systolic blood pressure in the offspring, but not with their measures of diastolic blood pressure, body mass index, waist circumference, homeostatic model assessment of insulin resistance, glucose, or lipids.

Introduction

Preeclampsia is linked to hypertension and stroke in the adult offspring.¹⁻⁴ Furthermore, there is a growing body of evidence that the cardiometabolic health of the offspring of pregnancies affected by preeclampsia is impaired as early as childhood. In a systematic review, Davis and colleagues⁵ surmised that preeclampsia is consistently associated with higher blood pressure and body mass index as early as 4-10 years of age. Even gestational hypertension, in the absence of proteinuria, elevated liver enzymes, or thrombocytopenia, is associated with higher blood pressure in young offspring.^{6,7}

Several mechanisms may explain the association between pregnancy-associated hypertension and offspring blood pressure. The potential mechanisms likely represent a complex interplay of several mechanisms including fetal programming, genetics, and shared environment. Barker and colleagues⁸ hypothesized that shallow invasion of the spiral arteries

leads to fetal malnutrition. Fetal programming may also involve a response to inflammation and endothelial dysfunction associated with preeclampsia.⁹

The association between pregnancy-associated hypertension (gestational hypertension and preeclampsia) and cardiometabolic markers other than blood pressure, such as lipid profile and glucose metabolism, is less clear.⁵ Therefore, the objective of this study was to evaluate whether pregnancy-associated hypertension was associated with the cardiometabolic health of the offspring at 5-10 years of age.

Materials and Methods

From February 2012 through September 2013, we conducted a prospective observational follow-up study of the offspring of women who participated in the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal-Fetal Medicine Units (MFMU) Network mild gestational diabetes mellitus (GDM) treatment trial and observational study.^{10,11} The follow-up study was not planned at the time of the original study. Both the original study and the follow-up study were approved by the institutional review board of all participating centers. From October 2002 through mid-November 2007, pregnant women with and without mild GDM who consented were enrolled in the MFMU Network's mild GDM study, the methods of which have been previously described.¹⁰

Pregnancy complications were collected as part of the original study.¹⁰ Pregnancy-associated hypertension included both gestational hypertension and preeclampsia. Gestational hypertension was defined as meeting either of the following criteria: 1) diastolic blood pressure 90 or greater or systolic blood pressure 140 or greater on two occasions at least four hours apart; or 2) one elevated blood pressure subsequently treated with anti-hypertensive medication. Preeclampsia was defined as elevation in blood pressure as defined above plus meeting any of the following criteria: 1) proteinuria (24-hour urine protein ≥ 300 mg/24 hours or 24-hour urine not done and $\geq 2+$ on dipstick in absence of a urinary tract infection, or 24-hour urine not done and protein-creatinine ratio ≥ 0.35); 2) elevated liver enzyme serum levels (serum glutamic oxaloacetic transaminase ≥ 70 unit/L or lactic acid dehydrogenase ≥ 600 unit/L); or 3) thrombocytopenia (platelet count $<100,000/\text{mm}^3$); in absence of any other known cause of elevated blood pressures, proteinuria, elevated enzymes, or decreased platelets. All suspected cases of pregnancy-associated hypertension were centrally reviewed and adjudicated during the original study by two protocol subcommittee physician members who were masked to the participants' group assignment. Preterm delivery was defined as delivery less than 37 weeks, 0 days of gestation, with gestational age confirmed by ultrasound before enrollment. For the present analysis, children were categorized into one of four groups according to their in utero exposure to maternal pregnancy-associated hypertension and the timing of their delivery: 1) maternal pregnancy-associated hypertension and delivered preterm; 2) maternal pregnancy-associated hypertension and delivered at term; 3) normotensive pregnancy and delivered preterm; 4) normotensive pregnancy and delivered at term (reference group).

Following parental informed consent, and child assent when appropriate, children of the index pregnancy were enrolled 5-10 years after delivery.¹¹ Eligibility for the follow-up study

included enrollment in the original study at a center still participating in the MFMU Network at the time of the follow-up study (12 of 16 centers; 92% of the participants from the original study). At follow-up, parents were queried about breast feeding and their child's current diet, physical activity, and if anyone in the household was receiving public assistance (food stamps, Medicaid benefits, or welfare). Parents were also asked if their child showed any signs of pubertal changes using drawings and descriptions of the five Tanner stages,¹² and their responses were coded as no (Tanner equals one) or yes (Tanner greater than one) for any signs of puberty.

The children had their height and weight measured using a hospital-grade scale and a stationary stadiometer, respectively, which were used to estimate child body mass index. Waist circumference was measured just above the uppermost lateral border of the right ilium of the pelvis,¹³ and an average of three measurements was used in the analysis. Blood pressure was measured by auscultation using aneroid sphygmomanometer instruments or a hospital grade blood pressure or pulse machine, and an average of two measurements was used in the analysis.

Following an eight-hour fast, the children had their blood drawn. Specimens were collected per a standardized approach and analyzed at the Northwest Lipid Metabolism and Diabetes Research Laboratories for lipid panel, glucose and insulin. The glucose and insulin measurements were used to estimate homeostasis model assessment-estimated insulin resistance, calculated as $(\text{fasting glucose [mmol/L]} \times \text{fasting insulin [uU/mL]}) / 22.5$.¹⁴ To minimize bias, research staff involved in data collection and laboratory analyses were masked to the participants' exposures during the original study.

Although several definitions of metabolic syndrome in children exist, there is no one standard, particularly in children less than 10 years of age. Developmental and pubertal changes during childhood and adolescence, and differences between males and females, complicate the ability to establish appropriate cut-points for cardiometabolic risk factors in children.^{15,16} Metabolic syndrome in children has generally included the following measures: blood pressure, glucose, high-density lipoprotein cholesterol, triglycerides, and either waist circumference or body mass index.^{15,17-19} We therefore evaluated each of these measures, as well as homeostatic model assessment of insulin resistance which is associated with other cardiometabolic risk factors and metabolic dysfunction in children.^{20,21}

Baseline characteristics were compared between follow-up participants and non-participants using the chi-square test or Fisher's exact test for categorical variables and the Wilcoxon rank sum test for continuous variables. Descriptive analyses evaluating characteristics by exposure group used the chi-square test or Fisher's exact test for categorical variables and the Kruskal-Wallis test for continuous variables. To describe shared health and lifestyle between mother and child, we estimated the correlation (Spearman) between maternal and child blood pressure, diet (vegetable consumption) and exercise (average exercise in the child and vigorous exercise in the mother). Continuous variables were assessed to evaluate whether they were normally distributed and log-transformed when appropriate.

The cardiometabolic outcomes were each evaluated as continuous outcomes using comparisons of least squares means based on multivariable linear regression models. Several variables were considered in the multivariable analysis, including maternal baseline characteristics during the index pregnancy (study group [mild GDM treated, mild GDM untreated, no GDM], self-reported race and ethnicity, body mass index, and smoking). The child characteristics considered in the multivariable analysis included sex and age at follow-up. Child height at follow-up was considered for the blood pressure models. For any statistically significant associations observed, we evaluated whether associations remained significant after further adjustment for the potentially mediating effect of either birthweight for gestational age or child body mass index. Birthweight for gestational age was estimated per methods of Alexander et al²² (personal communication, G. Alexander, 2000) using neonatal gestational age at delivery, birthweight, and sex and maternal race and ethnicity to categorize newborns into three groups: small for gestational age (birthweight less than 10th percentile for gestational age), appropriate for gestational age (birthweight 10th to 90th percentile for gestational age; reference group), and large for gestational age (birthweight greater than 90th percentile for gestational age). Multivariable models were developed for the cohort overall and to test for interaction between pregnancy-associated hypertension and child sex and between pregnancy-associated hypertension and puberty status.

Our sample size was not large enough to evaluate gestational hypertension and preeclampsia separately in multivariable analysis, however we conducted an unadjusted analysis to describe the cardiometabolic risk factors separately for gestational hypertension and preeclampsia.

A post hoc analysis was conducted to determine the frequency of hypertension by exposure group to aide in the clinical interpretation of the results. Hypertension was defined as either a systolic or diastolic value greater than the 95th percentile for gender, age and height centile per the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents.²³ Due to the small cell sizes, this analysis was descriptive only and did not include multivariable analysis.

SAS software was used for the analyses. All tests were two-tailed and $p < .05$ was used to define statistical significance. No imputation for missing data was performed.

Results

Nine hundred eighty-one children participated in the follow-up study (56% of the 1737 children born to women enrolled in the original study at a center that participated in the follow-up portion) (Figure 1). One child was excluded from this analysis because of missing anthropometric data and another child was excluded due to missing data regarding exposure to pregnancy complications, leaving 979 children included in this analysis. All 979 of these children had anthropometric measurements, including height, weight, and waist circumference. Blood pressure was measured in 974 of the children and a blood specimen was collected in 765 of the children.

The maternal baseline characteristics were generally similar between the children who did and did not participate, although some differences were observed. Most notably, a higher percentage of the children of non-Hispanic white women participated in the follow-up study (Appendix 2, available online at <http://links.lww.com/xxx>). Still, this was an ethnically-diverse cohort with 56% of participating children born to women of Hispanic ethnicity. The percent of children whose mothers experienced pregnancy-associated hypertension or were delivered preterm was similar between participants and non-participants.

The children were evaluated at a median 7 years of age (interquartile range 6-8). The number of children in each exposure group was 23 (2%) from a hypertensive pregnancy and born preterm, 73 (7%) from a hypertensive pregnancy and born at term, 58 (6%) from a normotensive pregnancy and born preterm, and 825 (84%) from a normotensive pregnancy and born at term. Among the mothers with a hypertensive pregnancy, 57% of the mothers who delivered preterm had preeclampsia and 30% of the mothers who delivered at term had preeclampsia. Among the mothers that delivered preterm, 69% of the mothers with a normotensive pregnancy experienced spontaneous preterm birth, whereas 13% of the mothers with a hypertensive pregnancy experienced spontaneous preterm birth. Twenty four percent of the children showed some signs of puberty (Table 1). The women who had pregnancy-associated hypertension and delivered preterm had the highest body mass index. A significant correlation was observed between maternal and child diet (vegetable consumption); weak correlations between mother and child were observed for exercise and systolic blood pressure.

When evaluating unadjusted outcomes, mean systolic blood pressure was significantly higher in the children who were born at term to mothers who experienced pregnancy-associated hypertension compared with those born at term to normotensive mothers (systolic blood pressure of 104 mmHg, 95% CI 101-106 vs. systolic blood pressure of 99 mmHg, 95% CI 98-100, $p=.002$)(Table 2). The multivariable models were adjusted for maternal baseline self-reported race and ethnicity and body mass index, and child sex. The blood pressure models were also adjusted for child height at follow-up; all other models were also adjusted for child age at follow-up. The results were similar if further adjusted for study group (mild GDM treated, mild GDM untreated, no GDM) and smoking during pregnancy; therefore these variables were excluded as adjusters to maintain a more parsimonious model. Results of the adjusted models were similar to the unadjusted results. Mean adjusted systolic blood pressure was significantly higher in the children who were born at term to mothers who experienced pregnancy-associated hypertension compared with those born at term to normotensive mothers (systolic blood pressure of 104 mmHg, 95% CI 101-106 vs. systolic blood pressure of 99 mmHg, 95% CI 99-100, $p=.001$) (Table 3). Results were consistent across child sex and Tanner stage groups. The other cardiometabolic risk factors did not significantly differ between exposure groups. No significant differences were observed when comparing the children who were born preterm (from either a hypertensive pregnancy or a normotensive pregnancy) with those born at term to normotensive mothers. The association between pregnancy-associated hypertension at term and systolic blood pressure (Appendix 3 [Panel A], available online at <http://links.lww.com/xxx>) was not attenuated after further adjustment for the potentially mediating effect of either birthweight for gestational age (Appendix 3 [Panel B], <http://links.lww.com/xxx>) or child body mass index (Appendix 3

[Panel C], <http://links.lww.com/xxx>). Overall, 11% of the children had hypertension, which ranged from 10% in those born at term to a normotensive pregnancy to 23% in those born at term to a hypertensive pregnancy (Appendix 4, available online at <http://links.lww.com/xxx>).

Descriptive results evaluating gestational hypertension and preeclampsia separately for systolic blood pressure are presented in Appendix 5, available online at <http://links.lww.com/xxx>. Elevated systolic blood pressure was observed in the children born at term to mothers with gestational hypertension and preeclampsia.

Discussion

We found that pregnancy-associated hypertension in women who deliver at term was associated with higher systolic blood pressure in the offspring, however no association was observed in those born preterm. It is possible that an earlier delivery may protect a fetus from continued in utero exposure to the sequelae of pregnancy-associated hypertension, however the relatively modest sample size of those born preterm limits our interpretation. In an analysis from this same study, we found that pregnancy-associated hypertension was associated with subsequent maternal blood pressure in the mothers who delivered preterm.²⁴ This difference in at-risk groups for higher systolic blood pressure between mothers and their offspring may argue against a strong genetic or shared environment mechanism in our population. We observed no significant association between pregnancy-associated hypertension and the other cardiometabolic measures evaluated, suggesting that the adverse consequences of in utero exposure to pregnancy-associated hypertension is specific to child blood pressure.

Our findings of an association between pregnancy-associated hypertension with offspring systolic blood pressure, but not other cardiometabolic markers, are consistent with other studies. The United Kingdom Avon Longitudinal Study followed up over 6000 offspring of women with preeclampsia, gestational hypertension, or normotension from 7-18 years after birth.^{6,25-27} Maternal gestational hypertension and preeclampsia were associated with higher systolic blood pressure in the 7, 9, and 11-year old offspring.^{6,25,27} Endothelial function, markers of inflammation, and lipids were also measured in the 11-year old offspring and none was significant.²⁵ In a study conducted in Finland in 60 12-year old children born after a preeclamptic pregnancy and 60 matched controls, preeclampsia was associated with offspring blood pressure and epinephrine, but not with total cholesterol, low-density lipoprotein cholesterol, or insulin.²⁸

Whether elevations in cardiometabolic risk factors other than blood pressure may emerge later in adolescence or early adulthood remains inconclusive. In a cohort of 5573 16-year old adolescents part of the Northern Finland Birth Cohort 1986, gestational hypertension was associated with higher blood pressure, total cholesterol and apolipoprotein B, but no statistically significant association was observed for insulin, glucose, homeostatic model assessment of insulin resistance, high-density lipoprotein cholesterol, or triglycerides.⁷ In the 17-year old adolescents enrolled in the Avon Longitudinal Study, gestational hypertension and preeclampsia were associated with offspring blood pressure, but not with insulin, glucose or lipids.²⁶ A subgroup of these adolescents had echocardiography, and

gestational hypertension and preeclampsia were associated with offspring cardiac wall thickness, but not cardiac function.²⁹ In a cohort of 2868 20 year-old adults in Australia, pregnancy-associated hypertension was associated with offspring hypertension, body mass index, and a global lifetime risk score above the 75th percentile, however not with the individual measures of insulin, glucose, or lipids.⁴ In the Helsinki Health Cohort of over 5000 older adults, exposure to in utero gestational hypertension and preeclampsia was associated with hypertension and stroke in the offspring, but not with coronary heart disease,¹ and gestational hypertension was associated with type 2 diabetes medication use before age 62.³⁰

Limitations of this study are acknowledged. The sample size was relatively small for those born preterm and those exposed to preeclampsia. Because the follow-up study was not planned at the time of the original study, 44% were lost to follow-up. This could lead to bias in the results, although it is noted that the children included in the analysis and the children not included in the analysis were similar with respect to exposure to pregnancy-associated hypertension and preterm birth. In addition, our results may be specific to children born to women with mild GDM or lesser degrees of carbohydrate intolerance, although our results are consistent with the literature.

There are numerous strengths of this study. Our study provided an opportunity to evaluate the association between pregnancy-associated hypertension and cardiometabolic health of offspring. The mothers of the index children were enrolled during pregnancy and therefore pregnancy outcomes were prospectively collected and defined using rigorous criteria and under a standardized research setting, rather than relying on maternal self-report, vital statistics, or administrative data sets. Cases of pregnancy-associated hypertension were reviewed and adjudicated and gestational age at delivery was based on dating confirmed by ultrasound. Likewise, data at the follow-up visit were prospectively and rigorously collected, trained research staff performed anthropometric and blood pressure measurements, and cardiometabolic markers were measured at a central laboratory.

Our findings suggest that children born to mothers experiencing pregnancy-associated hypertension may be candidates for regular blood pressure measurements, even if not overweight. Furthermore, these findings, coupled with other studies, can inform hypertension prevention strategies that may impact maternal hypertension, as well as offspring hypertension.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Enrollment, follow-up, and exposure status of the children. Dashed line indicates in utero exposure to maternal pregnancy-associated hypertension and timing of delivery

Table 1
Baseline and follow-up characteristics by in utero exposure to maternal pregnancy-associated hypertension and timing of delivery

Characteristic	Pregnancy-associated hypertension			P*
	Preterm n=23	Term n=73	Normotensive Preterm n=58 Term n=825	
Baseline maternal characteristics				
Race and ethnicity				.64
Hispanic	13 (56.5)	38 (52.1)	27 (46.6)	468 (56.7)
Non-Hispanic white	6 (26.1)	24 (32.9)	19 (32.8)	246 (29.8)
Non-Hispanic other	4 (17.4)	11 (15.1)	12 (20.7)	111 (13.5)
Group				.49
Mild GDM treated	5 (21.7)	20 (27.4)	22 (37.9)	217 (26.3)
Mild GDM untreated	8 (34.8)	18 (24.7)	13 (22.4)	197 (23.9)
No GDM	10 (43.5)	35 (48.0)	23 (39.7)	411 (49.8)
Smoked cigarettes at any time during this pregnancy	0 (0.0)	5 (6.9)	10 (17.2)	59 (7.2)
BMI at enrollment, kg/m ²	33.3 (29.1-35.8)	31.5 (28.2-35.4)	29.1 (25.2-34.0)	29.5 (26.8-32.5)
Infant characteristic (retrospective recall)				<.001
Ever breast fed	19 (82.6)	57 (78.1)	41 (70.7)	650 (78.8)
Follow-up child characteristics				
Male sex	13 (56.5)	31 (42.5)	28 (48.3)	425 (51.5)
Tanner greater than 1 (showing signs of puberty) [‡]	5 (21.7)	16 (21.9)	16 (27.6)	196 (23.8)
Age at follow-up, y	7 (6-9)	7 (6-8)	7 (6-8)	7 (6-8)
Member of child's household received food stamps, Medicaid benefits or welfare in past 12 months	15 (65.2)	48 (65.8)	30 (51.7)	485 (58.8)
Vegetable servings (other than potatoes or corn), 1/2 cup/d	0.6 (0.1-1.0)	0.7 (0.4-2.0)	0.9 (0.4-1.0)	0.7 (0.3-1.0)
Dairy servings (other than ice cream), 1/2 cup/d	1.0 (0.7-3.0)	2.0 (1.0-3.0)	2.0 (1.0-3.0)	2.0 (1.0-3.0)
Fruit juice, cups/d	1.0 (0.6-2.0)	1.0 (0.3-2.0)	1.0 (0.3-2.0)	1.0 (0.3-2.0)
Sweetened beverages, cups/d	1.0 (0.1-1.0)	0.3 (0.1-1.0)	0.4 (0.1-2.0)	0.6 (0.1-1.0)
Exercise average hrs/d	2.8 (1.6-4.1)	2.3 (1.5-3.4)	2.7 (1.9-3.6)	2.2 (1.5-3.3)
Correlation coefficient between follow-up maternal and child characteristics [‡]				
Diet (maternal and child vegetable servings)	0.68 (p<.001)	0.71 (p<.001)	0.53 (p<.001)	0.48 (p<.001)
Exercise (maternal vigorous and child average)	-0.05 (p=.83)	0.09 (p=.43)	0.19 (p=.17)	0.08 (p=.02)

Characteristic	Pregnancy-associated hypertension				Normotensive		P*
	Preterm n=23	Term n=73	Preterm n=58	Term n=825	Preterm n=58	Term n=825	
Systolic blood pressure [§]	-0.02 (p=.93)	0.21 (p=.08)	0.22 (P=.11)	0.21 (p<.001)			

GDM, gestational diabetes mellitus; BMI, body mass index.

Data are n (%) or median (interquartile range) unless otherwise specified.

* Based on the chi-square or Fishers exact test for categorical variables and the Kruskal-Wallis test for continuous variables; a comparison across all four groups.

[†]Missing in 1 child.

[‡]Maternal follow-up data missing in 31.

[§]Missing in 5 children.

Unadjusted association between in utero exposure to maternal pregnancy-associated hypertension and timing of delivery and child cardiometabolic health at follow-up

Table 2

	Pregnancy-associated hypertension						Normotensive					
	Preterm n=23			Term n=73			Preterm n=58			Term n=825		
	Unadjusted mean (95%CI)	P	Unadjusted mean (95%CI)	P	Unadjusted mean (95%CI)	P	Unadjusted mean (95%CI)	P	Unadjusted mean (95%CI)	P	Unadjusted mean (95%CI) (reference group)	
Systolic blood pressure, mmHg [*]	100 (95-105)	.74	104 (101-106)	.002	98 (95-101)	.29	99 (98-100)					
Diastolic blood pressure, mmHg [*]	60 (56-63)	.94	61 (59-63)	.29	60 (58-62)	.91	60 (59-60)					
Triglycerides, mg/dL [‡]	70.7 (57.6-86.8)	.28	65.1 (58.0-73.1)	.60	63.8 (55.9-72.9)	.86	63.0 (60.8-65.3)					
HDL cholesterol, mg/dL [‡]	51.9 (46.4-57.5)	.87	51.8 (48.7-55.0)	.72	52.1 (48.4-55.7)	.85	52.4 (51.5-53.4)					
Glucose, mg/dL [§]	89.4 (86.1-92.6)	.98	90.1 (88.3-91.9)	.43	87.6 (85.5-89.7)	.12	89.3 (88.8-89.8)					
HOMA-IR	1.4 (1.0-2.0)	.24	1.3 (1.1-1.6)	.12	1.1 (0.9-1.3)	.59	1.1 (1.1-1.2)					
Waist circumference, cm [¶]	60.8 (57.2-64.8)	.11	59.4 (57.4-61.5)	.14	59.0 (56.7-61.3)	.32	57.8 (57.2-58.4)					
BMI, kg/m ² [#]	18.1 (16.7-19.7)	.21	18.1 (17.2-18.9)	.05	17.2 (16.3-18.1)	.96	17.2 (17.0-17.4)					

HDL, high-density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance; BMI, body mass index.

^{*} Measured in 974 children.

[†] Back-transformation of the log value; measured in 765 children.

[‡] Measured in 764 children.

[§] Measured in 765 children.

^{||} Calculated as (fasting glucose [mmol/L] × fasting insulin [μU/mL] / 22.5)¹³; back-transformation of the log value; measured in 764 children.

[¶] Back-transformation of the log value; measured in 979 children.

[#] Back-transformation of the log value; measured in 979 children.

Table 3

Adjusted* association between in utero exposure to maternal pregnancy-associated hypertension and timing of delivery and child cardiometabolic health at follow-up

	Pregnancy-associated hypertension				Normotensive			
	Preterm n=23		Term n=73		Preterm n=58		Term n=825	
	Adjusted mean (95%CI)	P	Adjusted mean (95%CI)	P	Adjusted mean (95%CI)	P	Adjusted mean (95%CI) (reference group)	
Systolic blood pressure, mmHg [†]	99 (94-103)	.78	104 (101-106)	.001	97 (94-100)	.16	99 (99-100)	
Diastolic blood pressure, mmHg [†]	59 (55-62)	.50	61 (59-63)	.23	60 (57-62)	.87	60 (59-60)	
Triglycerides, mg/dL [‡]	70.1 (57.4-85.7)	.29	66.1 (59.0-73.9)	.41	64.7 (56.8-73.6)	.69	62.9 (60.8-65.1)	
HDL cholesterol, mg/dL [§]	51.4 (45.9-56.9)	.72	52.2 (49.1-55.3)	.91	51.8 (48.3-55.4)	.76	52.4 (51.5-53.4)	
Glucose, mg/dL/	88.5 (85.3-91.7)	.62	90.5 (88.7-92.3)	.22	87.8 (85.8-89.9)	.17	89.3 (88.8-89.8)	
HOMA-IR [¶]	1.2 (0.9-1.7)	.64	1.4 (1.2-1.6)	.05	1.1 (0.9-1.3)	.72	1.1 (1.1-1.2)	
Waist circumference, cm [#]	58.7 (55.6-62.1)	.59	59.3 (57.5-61.2)	.12	58.9 (56.9-61.0)	.30	57.8 (57.3-58.4)	
BMI, kg/m ² **	17.1 (15.9-18.5)	.85	17.7 (17.0-18.5)	.07	17.0 (16.2-17.8)	1.00	17.0 (16.8-17.2)	

HDL, high-density lipoprotein; HOMA-IR, homeostatic model assessment of insulin resistance; BMI, body mass index.

* All models were adjusted for maternal baseline race, ethnicity, and BMI, and child sex; the blood pressure models were also adjusted for child height at follow-up; all other models were also adjusted for child age at follow-up; p-values are compared with children born at term to normotensive mothers.

[†] Measured in 974 children.

[‡] Back-transformation of the log value; measured in 765 children.

[§] Measured in 764 children.

[¶] Measured in 765 children.

[#] Calculated as (fasting glucose [mmol/L] × fasting insulin [μU/mL] / 22.5)¹³; back-transformation of the log value; measured in 764 children.

** Back-transformation of the log value; measured in 979 children.

** Back-transformation of the log value; measured in 979 children.