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Descriptive Epidemiology of Chronic Hypertension, Gestational Hypertension, and Preeclampsia in New York State, 1995–2004

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Abstract

We examined social, demographic, and behavioral predictors of specific forms of hypertensive disorders in pregnancy in New York State. Administrative data on 2.3 million births over the period 1995–2004 were available for New York State, USA, with linkage to birth certificate data for New York City (964,071 births). ICD-9 hospital discharge diagnosis codes were used to assign hypertensive disorders hierarchically as chronic hypertension, chronic hypertension with superimposed preeclampsia, preeclampsia (eclampsia/severe or mild), or gestational hypertension. Sociodemographic and behavioral predictors of these outcomes were examined separately for upstate New York and New York City by calculating adjusted odds ratios. The most commonly diagnosed conditions were preeclampsia (2.57 % of upstate New York births, 3.68 % of New York City births) and gestational hypertension (2.46 % of upstate births, 1.42 % of New York City births). Chronic hypertension was much rarer. Relative to non-Hispanic Whites, Hispanics in New York City and Black women in all regions had markedly increased risks for all hypertensive disorders, whereas Asian women were at consistently decreased risk. Pregnancy-associated conditions decreased markedly with parity and modestly among smokers. A strong positive association was found between pre-pregnancy weight and risk of hypertensive disorders, with slightly weaker associations among Blacks and stronger associations among Asians. While

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patterns of chronic and pregnancy-induced hypertensive disorders differed, the predictors of gestational hypertension and both mild and severe preeclampsia were similar to one another. The increased risk for Black and some Hispanic women warrants clinical consideration, and the markedly increased risk with greater pre-pregnancy weight suggests an opportunity for primary prevention among all ethnic groups.

Keywords

Chronic hypertension; Gestational hypertension; Preeclampsia

Introduction

Hypertensive disorders are common complications of pregnancy, with a wide range of severity, ranging from chronic or gestational hypertension to severe preeclampsia and eclampsia, which can be life-threatening for the mother and fetus and may result in very preterm birth [1]. Birth records provide comprehensive data on the population, but with limited specificity of diagnosis and substantial misclassification as compared to medical record review [2, 3]. Hospital discharge diagnoses are superior to birth certificates for this purpose [3]. A distinct but largely unexploited advantage of discharge diagnoses over birth certificates is the ability to examine *specific* hypertensive disorders, not well developed in previous studies [4, 5]. We combined the advantages of administrative data for diagnostic accuracy with the wide range of predictors available from linkage to birth certificates to conduct a comprehensive evaluation of the relationship between sociodemographic factors, behaviors, and reproductive history and the full spectrum of specific hypertensive disorders that can occur in pregnancy.

Methods

Hospital discharge data for all births in New York State (including New York City) for the period 1995–2004 were obtained from the Statewide Planning and Research Cooperative System. We restricted analyses to singleton, live births. Starting with the 2,285,108 births in all of New York State, they were divided into subsets based on residence in New York City or upstate New York. We linked birth certificate information to the hospital discharge data for the subset of births to residents of New York City who were born in New York City Hospitals and had birth certificate information available. Out of 1,098,664 births to New York City residents, 964,091 were in New York City hospitals (87.8 %) and had birth certificates available for linkage. We also examined 1,186,444 births in upstate New York that did not have birth certificates available for linkage. Birth hospitalizations were identified based on ICD diagnostic codes, with information available on the mother’s age, ethnicity, county of residence, insurance status, and up to 15 ICD codes for medical conditions, which included diagnostic codes for the full range of hypertensive disorders of interest. Urban/rural status was categorized according to National Center for Health Statistics guidelines based on county population size) listed from most urban to most rural: metropolitan area: large central counties in metro area greater than 1 million population; metropolitan area: large fringe counties in metro area greater than 1 million population;

medium metropolitan area: counties in metro area 250,000–999,999 population; small metropolitan area: counties in metro area 50,000–249,999 population; micropolitan counties; non-core counties [6]. For births to residents of New York City only, the linkage to birth certificate data yielded additional predictors of interest, including more detailed ethnicity, parity, education, tobacco use, and pre-pregnancy weight. (Restrictions on access precluded linkage of birth certificate data for upstate residents.)

Women were identified as having been diagnosed with a given hypertensive disorder if a corresponding ICD code appeared in any of the 15 medical diagnosis fields (Table 1). We developed a hierarchy for assigning each pregnancy to one and only one outcome group, necessary because some women had more than one type of hypertensive disorder assigned. We first prioritized based on whether chronic hypertension was present or not. Then among women whose onset of hypertension occurred during pregnancy, we considered severity, assigning the most severe diagnosis that was listed. Starting with those diagnosed with chronic hypertension, we distinguished those with “chronic hypertension with no superimposed preeclampsia” (Table 1) and “chronic hypertension with superimposed preeclampsia”. Among women without chronic hypertension, we began by identifying women with an assignment of “eclampsia or severe preeclampsia”. Among remaining women, we then assessed whether “mild preeclampsia” was reported, and if it was not, whether “gestational hypertension” was reported. This resulted in the following categories, each compared to the referent with “no hypertensive disorders”: chronic hypertension alone, preeclampsia superimposed on chronic hypertension, severe preeclampsia/eclampsia and mild preeclampsia (aggregated and separated), and gestational hypertension.

The predictors of hypertensive disorders were distinctive for upstate New York and New York City based on data availability. For upstate New York, predictors evaluated included calendar time, maternal age, maternal race/ethnicity, insurance type, and urban/rural county of residence. For New York City, these same predictors (except urban/rural county of residence) were studied, with the addition of parity, maternal education, detailed ethnicity, prenatal smoking, onset of prenatal care, and pre-pregnancy weight. The association between prepregnancy weight and hypertensive disorders was examined in subgroups defined by ethnicity (non-Hispanic White, Black, Hispanic, and Asian).

The crude odds ratio was used to estimate relative risks for each of the specific hypertensive disorders compared to no hypertensive disorders (excluding women with more severe/chronic forms of hypertensive disorders). An adjusted odds ratio with 95 % confidence interval that incorporated all the other predictors was derived by multinomial logistic regression using SAS v. 9.3. Access to the data required approval from Institutional Review Boards of the New York City Department of Health and Mental Hygiene, New York State Department of Health, and the Data Protection Review Board of the Statewide Cooperative Research and Evaluation System; and the research was approved by the Brown University Institutional Review Board.

Results

The results for upstate New York and New York City are presented separately. The most commonly diagnosed conditions were preeclampsia (2.57 % of upstate New York births, 3.68 % of New York City births) and gestational hypertension (2.46 % of upstate births, 1.42 % of New York City births). Isolated chronic hypertension was rarer (0.83 and 0.85 %, respectively), as was preeclampsia superimposed on chronic hypertension (0.23 and 0.38 %, respectively).

Risk of chronic hypertension, especially without superimposed preeclampsia, increased over the time period of the study, and rose markedly with advancing maternal age. Chronic hypertension was notably more common among Black women and less common among Hispanic and Asian women in upstate New York (Table 2) whereas in New York City (Table 3), Hispanic women had increased risk. Chronic hypertension was more common among women with public insurance relative to those with private insurance. In upstate New York, there was evidence of greater risk in more rural areas of the state. In New York City, risk declined with advancing parity (especially for preeclampsia superimposed on chronic hypertension), and declined with increased education, with little association with smoking or prenatal care onset. Risk increased markedly with higher pre-pregnancy weight; a clear, monotonic dose–response gradient culminating in greater than sixfold increased risks. The magnitude of increase was somewhat greater for Asian women (though high prepregnancy weight was rarer) and more muted among Black women (Tables 4 and 5). The differences in pattern between isolated chronic hypertension and preeclampsia superimposed on chronic hypertension were modest, with isolated chronic hypertension showing a greater increase over time, and somewhat weaker associations with maternal ethnicity, insurance status, and parity among New York City births.

The pattern for gestational hypertension showed some similarities and rather distinct differences from the pattern for chronic hypertension (Tables 2, 3). Risk increased over time, Hispanic and Asian women had decreased risk (upstate only), and rural women showed increased risk in upstate New York, consistent with results for chronic hypertension. Contrasting results included an absence of association with maternal age in upstate New York, a more modest gradient of increasing risk with advancing age in New York City, and less pronounced increased risk among Black women. There was a notably decreased risk among parous women and evidence of a decreased risk among smokers. A strong gradient was found with pre-pregnancy weight, somewhat less dramatic than for chronic hypertension.

Preeclampsia was examined in the aggregate and subdivided into “severe preeclampsia and eclampsia” (referred to as “severe”) and “mild preeclampsia,” which was more commonly diagnosed (1.86 % mild and 0.71 % severe in upstate New York, 2.83 % mild and 0.87 % severe in New York City) (Tables 6, 7). Risk of both forms of preeclampsia was stable over time, with the exception of a modest increase in severe preeclampsia in upstate New York. With regard to maternal age, adjusted odds ratios were increased for the youngest mothers (<20 years) in upstate New York and for the oldest mothers (35+) in New York City and otherwise flat. Given the inability to adjust for parity in New York State and increased

unadjusted rates for young women in New York City, residual confounding by parity is likely to largely explain this pattern. In both upstate New York and New York City, Black women were at increased risk (more so for severe than mild pre-eclampsia) and Asian women were at decreased risk. Also, Hispanic women and women with public insurance showed increased risk only in New York City. A small increased risk was found with increasing rurality in New York State. In New York City, parous women had dramatically lower risk. Women with more education had a decreased risk, and smokers had modestly reduced risk. A clear, monotonic gradient of increasing risk was found in relation to pre-pregnancy weight, but more muted than that for the other hypertensive disorders (Tables 4 and 5). With the exceptions noted above, few differences were seen in the predictors for severe and mild preeclampsia.

Discussion

Although the absolute frequencies of hypertensive disorders found in New York are broadly in the range reported in studies around the world [7–12], the patterns of hypertensive disorders by ethnicity that we were able to detect are particularly noteworthy, with Black women having markedly elevated risk of chronic hypertension (with or without superimposed preeclampsia) and increased risk of both severe and mild preeclampsia. These results were consistent in Upstate New York and New York City and expand upon the results of previous studies [4, 7, 13]. The risk ratios for Blacks tended to be greatest for the most severe forms of hypertensive disorders, pointing towards a need for research to understand the reasons and address this disparity, which has significant implications for disparities in other birth outcomes such as preterm birth and perinatal mortality.

Results for Hispanics were more complicated, with increased risks in New York City but not in New York State, likely a reflection of the distinctive subsets of Hispanics in the two settings. As found in a detailed study of patterns in New York City [14], risks differ across Hispanic subgroups. Asian women were at consistently decreased risk for hypertensive disorders, presumably driven by the lower risk among East Asians [14]. While there is the potential for residual confounding due to limited ability to adjust for pre-pregnancy body mass index (BMI) (which tends to be increased in Hispanic women and low in Asian women), these clues to etiology based on ethnic variation have yet to be exploited, with very little prior research on ethnic groups other than Black women.

Evidence for declining risk with higher socioeconomic status was present for some measures and outcomes, as reported elsewhere [13, 15, 16], but not strongly so. The expected marked decrease in risk for parous women was found for gestational hypertension and preeclampsia [10, 11]. Smokers had a modest decrease in risk for preeclampsia and gestational hypertension, also consistent with most previous studies though the magnitude varies considerably and is sometimes not seen, perhaps reflecting different smoking intensity across populations [13, 16–18].

The association between pre-pregnancy weight and risk of hypertensive disorders was striking in magnitude across all the hypertensive disorders, consistent with the studies that have addressed BMI [7, 13, 16, 19], which we could not examine directly given the lack of

data on height. The association with weight was stronger for chronic hypertension and gestational hypertension than for preeclampsia. The clear and possibly causal association has implications for understanding etiologic mechanisms and potential for prevention.

We had a large enough study to consider differences in pattern among the hypertensive disorders, and overall, there were more similarities than differences found. We did observe a rising trend over time for both chronic hypertension and gestational hypertension that was not found for preeclampsia, reflecting either unmeasured risk factors or perhaps a residual effect of increasing obesity not fully captured by pre-pregnancy weight, There are some notable differences primarily between chronic hypertension and pregnancy-associated disorders, with parity and smoking associated with reduced risk only for the latter. Advanced maternal age was strongly associated with chronic hypertension but not any of the forms of pregnancy-associated hypertension. The overall patterns for gestational hypertension and preeclampsia, both mild and severe, were quite similar, as reported by Ros et al. [20] using Swedish data. This would suggest that studies that do not clearly distinguish the disorders, or that are not large enough to isolate severe preeclampsia can nonetheless make inferences relevant to the more clinically consequential end of the spectrum. The impact clearly differs, but the etiology of the spectrum of disorders appears to have substantial similarities based on the patterns of occurrence.

There are limitations to the quality of the data that can be derived from administrative sources [3, 21], with both imperfect sensitivity of assessment and inconsistency between the subtypes of hypertensive disorders based on discharge diagnoses and full medical record review. Nonetheless, the positive predictive value and specificity have generally been in the range of 70 % or greater for preeclampsia [3, 22, 23], but there are studies that suggest values as low as 54 % [21]. These tend to be much better than for birth certificate data alone, with positive predictive values as low as 54 % reported and sensitivity of only 33 % compared to medical record review [2]. However, there are no data to assess whether the quality of information differs across subgroups of women, so that the contribution of error to the observed patterns cannot be addressed. The birth certificate predictors of interest tend to be accurate, but there is no quality control over the data collection following delivery and errors undoubtedly arise. There are inherent limitations in the scope and quality of available data: pre-pregnancy weight was reported but not pre-pregnancy height, so that BMI could not be calculated; the outcome measures are based solely on ICD codes and cannot consider timing of onset for pregnancy-induced hypertensive disorders; and stillbirths could not be included due to data limitations.

There are advantages of analyzing a resource of this nature that combines the diagnostic accuracy of hospital discharge data with the breadth of the population available and incorporates birth certificate predictors. Geographically representative populations provide information on social and demographic patterns of risk that is subject to bias when examined in clinically defined populations. The increased risks for Black and Hispanic women warrant both additional etiologic research and careful clinical management, and the marked impact of the obesity epidemic on these disorders is striking, calling for improved weight management prior to pregnancy.

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Table 1

ICD-9 codes used to classify hypertensive disorders before and during pregnancy

Condition	ICD-9 codes
Chronic hypertension with no superimposed preeclampsia	401.0, 401.1, 401.9, 405.01, 405.09, 405.11, 405.19, 405.91, 405.99, 416.0, 459.30, 459.31, 459.32, 459.33, 459.39, 642.00–642.04, 642.10–642.14, 642.20–642.24, but excluding codes 642.70–642.74
Chronic hypertension with superimposed preeclampsia	642.70–642.74
Eclampsia or severe preeclampsia	642.50–642.54, 642.60–642.64
Mild preeclampsia	642.40–642.44
Gestational hypertension	642.30–642.34, 642.90–642.94

Table 2

Predictors of chronic hypertension, with and without superimposed preeclampsia, and gestational hypertension in upstate New York, 1995–2004

	% of all births	Isolated chronic hypertension		Chronic hypertension with preeclampsia		Gestational hypertension	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Total number of births (#, %)	1,171,131	9,880 (0.83)		2,692 (0.23)		28,117 (2.46)	
Year							
1995–1998	38.7	1.0	1.0	1.0	1.0	1.0	1.0
1999–2001	30.9	1.1	1.1 (1.1, 1.2)	1.2	1.1 (1.0, 1.2)	1.2	1.2 (1.2, 1.3)
2002–2004	30.4	1.4	1.4 (1.3, 1.4)	1.2	1.1 (1.0, 1.3)	1.4	1.4 (1.4, 1.4)
Maternal age (years)							
< 20	7.9	0.4	0.3 (0.2, 0.3)	0.4	0.3 (0.3, 0.4)	1.1	1.1 (1.0, 1.1)
20–24	18.5	0.6	0.5 (0.5, 0.5)	0.7	0.6 (0.5, 0.7)	1.0	1.0 (0.9, 1.0)
25–29	25.9	1.0	1.0	1.0	1.0	1.0	1.0
30–34	29.7	1.3	1.4 (1.4, 1.5)	1.2	1.3 (1.2, 1.5)	0.9	0.9 (0.9, 1.0)
≥35	18.1	2.4	2.7 (2.5, 2.8)	2.3	2.6 (2.3, 2.9)	1.0	1.0 (1.0, 1.1)
Maternal race/ethnicity							
Non-Hispanic White	63.4	1.0	1.0	1.0	1.0	1.0	1.0
Black	8.6	2.1	2.8 (2.7, 3.0)	2.9	3.7 (3.3, 4.1)	1.1	1.2 (1.2, 1.3)
Hispanic	6.6	0.6	0.7 (0.7, 0.8)	0.7	0.9 (0.7, 1.1)	0.7	0.8 (0.8, 0.9)
Asian	1.9	0.6	0.5 (0.4, 0.6)	0.5	0.5 (0.3, 0.7)	0.6	0.6 (0.5, 0.7)
Unknown/other	19.6	1.0	1.0 (1.0, 1.1)	1.4	1.4 (1.3, 1.6)	0.9	0.9 (0.8, 0.9)
Insurance							
Private	70.2	1.0	1.0	1.0	1.0	1.0	1.0
Public	27.3	0.9	1.2 (1.1, 1.2)	1.0	1.2 (1.0, 1.3)	0.8	0.8 (0.8, 0.8)
Self-pay	2.6	0.7	0.8 (0.7, 1.0)	0.8	0.9 (0.7, 1.1)	0.8	0.8 (0.7, 0.9)
Urban/rural county							
Large central counties of metro area > 1 million pop	15.3	1.1	1.1 (1.1, 1.2)	1.0	1.0 (0.9, 1.2)	1.3	1.2 (1.2, 1.3)
Large fringe counties of metro area > 1 million pop	44.0	1.0	1.0	1.0	1.0	1.0	1.0
Medium metro: pop 250,00–999,999	21.7	1.2	1.4 (1.3, 1.5)	1.2	1.3 (1.2, 1.5)	1.3	1.3 (1.3, 1.3)

	% of all births	Isolated chronic hypertension		Chronic hypertension with preeclampsia		Gestational hypertension	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Small metro: pop 50,000–249,999	6.0	0.9	1.2 (1.1, 1.3)	0.9	1.2 (1.0, 1.5)	1.5	1.6 (1.5, 1.7)
Micropolitan counties	9.7	1.1	1.6 (1.4, 1.7)	0.8	1.2 (1.0, 1.4)	1.3	1.3 (1.3, 1.4)
Non-core counties	3.3	1.1	1.5 (1.4, 1.7)	1.2	1.8 (1.4, 2.2)	1.5	1.5 (1.5, 1.6)

[a]Mutually adjusted for all other variables in the table

Table 3

Predictors of chronic hypertension, with and without superimposed preeclampsia, and gestational hypertension in New York City, 1995–2004

	%of all births	Isolated chronic hypertension		Chronic hypertension with preeclampsia		Gestational hypertension	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Total number of births (#, %)	788,454	8,192 (0.85)		3,633 (0.38)		12,999 (1.42)	
Year							
1995–1998	35.4	1.0	1.0	1.0	1.0	1.0	1.0
1999–2001	30.1	1.0	1.0 (0.9, 1.1)	0.9	0.9 (0.8, 1.0)	1.1	1.1 (1.1, 1.2)
2002–2004	34.6	1.2	1.2 (1.1, 1.2)	0.9	0.9 (0.9, 1.0)	1.3	1.3 (1.3, 1.4)
Maternal age (years)							
< 20	9.2	0.5	0.5 (0.4, 0.5)	0.7	0.5 (0.4, 0.6)	1.3	1.1 (1.0, 1.2)
20–24	22.4	0.6	0.6 (0.5, 0.7)	0.8	0.7 (0.6, 0.8)	1.0	1.0 (0.9, 1.0)
25–29	26.5	1.0	1.0	1.0	1.0	1.0	1.0
30–34	24.9	1.6	1.7 (1.6, 1.9)	1.6	1.7 (1.5, 1.9)	1.2	1.2 (1.1, 1.3)
≥35	17.0	3.6	3.7 (3.5, 4.0)	3.4	4.0 (3.6, 4.4)	1.6	1.7 (1.6, 1.8)
Maternal race/ethnicity							
Non-Hispanic White	23.3	1.0	1.0	1.0	1.0	1.0	1.0
Black	21.7	2.8	2.3 (2.1, 2.5)	4.3	3.2 (2.8, 3.6)	1.4	1.3 (1.2, 1.4)
Hispanic	20.0	1.1	1.4 (1.2, 1.5)	1.7	1.8 (1.5, 2.0)	1.1	1.3 (1.2, 1.3)
Asian	8.2	0.7	1.1 (0.9, 1.3)	1.1	1.3 (1.0, 1.6)	0.6	0.9 (0.8, 0.9)
Unknown/other	26.7	1.5	1.7 (1.6, 1.8)	2.1	2.0 (1.8, 2.3)	1.3	1.4 (1.3, 1.5)
Insurance							
Private	41.9	1.0	1.0	1.0	1.0	1.0	1.0
Public	54.7	0.9	1.2 (1.1, 1.2)	1.3	1.5 (1.4, 1.7)	1.0	1.1 (1.0, 1.1)
Self-pay	3.4	1.0	1.2 (1.0, 1.3)	1.4	1.5 (1.2, 1.8)	0.7	0.8 (0.7, 0.9)
Parity							
0	45.3	1.0	1.0	1.0	1.0	1.0	1.0
1	30.4	1.1	0.8 (0.7, 0.8)	0.9	0.6 (0.6, 0.7)	0.6	0.5 (0.5, 0.6)
≥2	24.3	1.9	0.8 (0.7, 0.8)	1.5	0.6 (0.5, 0.6)	0.7	0.5 (0.5, 0.5)
Maternal education (years)							
< 12	24.9	0.8	1.0 (0.9, 1.1)	1.0	1.2 (1.1, 1.3)	0.9	1.0 (1.0, 1.1)

	%of all births	Isolated chronic hypertension		Chronic hypertension with preeclampsia		Gestational hypertension	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
12	32.8	1.0	1.0	1.0	1.0	1.0	1.0
13–16	31.5	1.0	0.9 (0.9, 1.0)	1.0	0.9 (0.9, 1.0)	1.1	1.0 (1.0, 1.1)
> 16	10.9	0.8	0.7 (0.7, 0.8)	0.7	0.7 (0.6, 0.8)	1.0	0.9 (0.8, 1.0)
Prenatal smoking							
No	96.8	1.0	1.0	1.0	1.0	1.0	1.0
Yes	3.2	1.3	1.0 (0.9, 1.2)	1.3	1.0 (0.8, 1.2)	0.8	0.8 (0.7, 0.9)
Prenatal care							
None or started in 3rd trimester	7.7	0.9	0.9 (0.8, 1.0)	1.2	1.0 (0.9, 1.1)	0.9	1.0 (0.9, 1.1)
Started 1st trimester	66.8	1.0	1.0	1.0	1.0	1.0	1.0
Started 2nd trimester	25.5	0.9	1.0 (0.9, 1.0)	1.1	1.0 (0.9, 1.1)	0.9	1.0 (0.9, 1.0)
Pre-pregnancy weight quintiles (lbs)							
≤118	21.5	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	23.0	1.7	1.6 (1.4, 1.8)	1.7	1.6 (1.3, 1.9)	1.3	1.3 (1.2, 1.4)
> 130 to ≤142	16.0	2.7	2.3 (2.0, 2.6)	2.4	2.2 (1.8, 2.6)	1.6	1.6 (1.5, 1.7)
> 142 to ≤165	20.8	4.2	3.4 (3.0, 3.8)	3.7	3.0 (2.5, 3.5)	2.2	2.2 (2.1, 2.4)
> 165	18.7	12.0	8.9 (7.9, 10.0)	8.7	6.3 (5.4, 7.4)	3.9	4.0 (3.8, 4.3)

[a]Mutually adjusted for all other variables in the table

Table 4

Pre-pregnancy weight as a predictor of chronic hypertension, with and without superimposed preeclampsia, and gestational hypertension in New York City, 1995–2004

	% of all births	Isolated chronic hypertension		Chronic hypertension with preeclampsia		Gestational hypertension	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Total number of births (#, %)		8,192 (0.85)		3,633 (0.38)		12,999 (1.42)	
All, quintiles (lbs)							
≤118	21.5	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	23.0	1.7	1.6 (1.4, 1.8)	1.7	1.6 (1.3, 1.9)	1.3	1.3 (1.2, 1.4)
> 130 to ≤142	16.0	2.7	2.3 (2.0, 2.6)	2.4	2.2 (1.8, 2.6)	1.6	1.6 (1.5, 1.7)
> 142 to ≤165	20.8	4.2	3.4 (3.0, 3.8)	3.7	3.0 (2.5, 3.5)	2.2	2.2 (2.1, 2.4)
> 165	18.7	12.0	8.9 (7.9, 10.0)	8.7	6.3 (5.4, 7.4)	3.9	4.0 (3.8, 4.3)
Non-Hispanic, White, quintiles (lbs)							
≤118	20.9	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	25.8	1.3	1.1 (0.8, 1.5)	1.4	1.4 (0.8, 2.2)	1.3	1.2 (1.0, 1.5)
> 130 to ≤142	17.9	2.1	1.9 (1.4, 2.6)	2.1	1.8 (1.1, 3.0)	1.7	1.6 (1.4, 1.9)
> 142 to ≤165	20.3	3.2	3.0 (2.3, 3.9)	2.5	2.2 (1.4, 3.6)	2.4	2.5 (2.1, 2.9)
> 165	15.2	9.8	8.9 (6.9, 11.4)	9.5	9.0 (5.9, 13.7)	4.6	5.0 (4.3, 5.9)
Black, quintiles (lbs)							
≤118	12.4	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	17.1	1.5	1.2 (0.9, 1.6)	1.7	1.6 (1.1, 2.3)	1.2	1.2 (1.0, 1.4)
> 130 to ≤142	14.2	2.1	1.6 (1.3, 2.1)	2.8	2.4 (1.7, 3.4)	1.3	1.3 (1.1, 1.5)
> 142 to ≤165	24.7	3.3	2.3 (1.8, 2.9)	3.7	2.9 (2.1, 4.0)	1.6	1.7 (1.4, 2.0)
> 165	31.6	7.9	5.4 (4.3, 6.7)	6.9	5.1 (3.7, 7.0)	2.9	3.0 (2.6, 3.5)
Hispanic, quintiles (lbs)							
≤18	20.8	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	24.1	1.6	1.5 (1.1, 2.0)	1.4	1.2 (0.8, 1.8)	1.3	1.4 (1.2, 1.6)
> 130 to ≤142	16.7	2.3	2.0 (1.5, 2.7)	2.1	1.9 (1.3, 2.8)	1.5	1.6 (1.4, 2.0)
> 142 to ≤165	21.4	2.9	2.4 (1.8, 3.2)	2.5	2.3 (1.6, 3.3)	2.0	2.2 (1.9, 2.6)
> 165	17.0	8.6	7.4 (5.6, 9.6)	4.9	4.6 (3.3, 6.5)	3.6	4.0 (3.4, 4.7)
Asian, quintiles (lbs)							

	% of all births	Isolated chronic hypertension		Chronic hypertension with preeclampsia		Gestational hypertension	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
≤118	47.8	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	26.7	2.4	2.5 (1.7, 3.8)	1.4	1.3 (0.7, 2.2)	1.4	1.4 (1.1, 1.8)
> 130 to ≤142	12.3	4.8	4.7 (3.1, 7.3)	2.3	2.2 (1.2, 3.9)	2.3	2.3 (1.7, 3.0)
> 142 to ≤165	9.8	6.6	6.4 (4.2, 9.8)	4.1	3.5 (2.0, 6.0)	3.1	3.2 (2.4, 4.2)
> 165	3.4	16.4	14.5 (9.2, 22.8)	9.6	7.8 (4.3, 14.3)	5.8	5.6 (4.0, 7.8)

[a] Adjusted for year of birth, maternal age, maternal race/ethnicity (only when not stratified), insurance, parity, education, prenatal smoking, prenatal care

Table 5

Pre-pregnancy weight as a predictor of aggregated preeclampsia, severe preeclampsia/eclampsia, and mild preeclampsia in New York City, 1995–2004

	% of all births	Aggregated		Severe/eclampsia		Mild	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Total number of births (#, %)		8,192 (0.85)		3,633 (0.38)		12,999 (1.42)	
All, quintiles (lbs)							
≤118	21.5	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	23.0	1.2	1.2 (1.1, 1.2)	1.2	1.2 (1.1, 1.3)	1.2	1.2 (1.2, 1.3)
> 130 to ≤142	16.0	1.3	1.4 (1.3, 1.4)	1.3	1.2 (1.1, 1.4)	1.4	1.4 (1.3, 1.5)
> 142 to ≤165	20.8	1.6	1.7 (1.6, 1.8)	1.4	1.4 (1.3, 1.6)	1.7	1.8 (1.7, 1.9)
> 165	18.7	2.3	2.4 (2.3, 2.5)	1.8	1.8 (1.6, 1.9)	2.4	2.6 (2.5, 2.8)
Non-Hispanic, White, quintiles (lbs)							
≤118	20.9	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	25.8	1.1	1.2 (1.1, 1.3)	1.1	1.2 (1.0, 1.4)	1.2	1.2 (1.1, 1.4)
> 130 to ≤142	17.9	1.4	1.5 (1.3, 1.6)	1.3	1.4 (1.1, 1.7)	1.4	1.5 (1.4, 1.7)
> 142 to ≤165	20.3	1.8	2.0 (1.8, 2.2)	1.5	1.6 (1.3, 1.9)	1.9	2.1 (1.9, 2.3)
> 165	15.2	2.7	3.1 (2.8, 3.4)	1.7	1.9 (1.5, 2.3)	3.0	3.5 (3.1, 3.9)
Black, quintiles (lbs)							
≤118	12.4	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	17.1	1.0	1.1 (1.0, 1.2)	1.0	1.0 (0.8, 1.2)	1.0	1.1 (1.0, 1.2)
> 130 to ≤142	14.2	1.0	1.1 (1.0, 1.2)	1.0	1.0 (0.8, 1.2)	1.1	1.1 (1.0, 1.3)
> 142 to ≤165	24.7	1.2	1.3 (1.2, 1.4)	1.0	1.1 (0.9, 1.3)	1.3	1.4 (1.3, 1.5)
> 165	31.6	1.6	1.8 (1.7, 2.0)	1.2	1.3 (1.1, 1.5)	1.7	2.0 (1.8, 2.2)
Hispanic, quintiles (lbs)							
≤118	20.8	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	24.1	1.1	1.2 (1.2, 1.4)	1.2	1.3 (1.1, 1.5)	1.1	1.2 (1.1, 1.4)
> 130 to ≤142	16.7	1.2	1.4 (1.3, 1.5)	1.2	1.3 (1.1, 1.5)	1.2	1.4 (1.3, 1.6)
> 142 to ≤165	21.4	1.4	1.7 (1.5, 1.8)	1.2	1.4 (1.2, 1.6)	1.4	1.8 (1.6, 1.9)
> 165	17.0	1.8	2.3 (2.1, 2.5)	1.6	1.9 (1.6, 2.2)	1.9	2.4 (2.2, 2.6)
Asian, quintiles (lbs)							
≤118	47.8	1.0	1.0	1.0	1.0	1.0	1.0

	% of all births	Aggregated		Severe/eclampsia		Mild	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
> 118 to ≤130	26.7	1.3	1.3 (1.2, 1.6)	1.2	1.3 (1.0, 1.9)	1.3	1.3 (1.1, 1.6)
> 130 to ≤142	12.3	1.7	1.9 (1.6, 2.2)	1.4	1.6 (1.1, 2.3)	1.8	2.0 (1.6, 2.4)
> 142 to ≤165	9.8	2.3	2.6 (2.2, 3.1)	2.4	2.6 (1.8, 1.2)	2.3	2.6 (2.2, 3.2)
> 165	3.4	3.2	4.0 (3.1, 5.0)	3.0	3.6 (2.3, 1.2)	3.3	4.0 (3.1, 5.2)

[a] Adjusted for year of birth, maternal age, maternal race/ethnicity (only when not stratified), insurance, parity, education, prenatal smoking, prenatal care

Table 6

Predictors of aggregated preeclampsia, severe preeclampsia/eclampsia, and mild preeclampsia in upstate New York, 1995–2004

	% of all births	Aggregated		Severe/eclampsia		Mild	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Total number of births (#, %)	1,171,131	30,116 (2.57)		8,388 (0.71)		21,728 (1.86)	
Year							
1995–1998	38.7	1.0	1.0	1.0	1.0	1.0	1.0
1999–2001	30.9	1.0	1.0 (0.9, 1.0)	1.1	1.1 (1.0, 1.1)	0.9	0.9 (0.9, 1.0)
2002–2004	30.4	1.0	1.0 (1.0, 1.0)	1.2	1.2 (1.1, 1.2)	0.9	0.9 (0.9, 0.9)
Maternal age (years)							
< 20	7.9	1.6	1.5 (1.5, 1.6)	1.7	1.5 (1.4, 1.7)	1.6	1.5 (1.5, 1.6)
20–24	18.5	1.1	1.1 (1.1, 1.2)	1.1	1.1 (1.0, 1.1)	1.2	1.1 (1.1, 1.2)
25–29	25.9	1.0	1.0	1.0	1.0	1.0	1.0
30–34	29.7	0.9	0.9 (0.8, 0.9)	0.9	0.9 (0.9, 1.0)	0.8	0.8 (0.8, 0.9)
≥35	18.1	1.0	1.0 (0.9, 1.0)	1.1	1.2 (1.1, 1.2)	0.9	0.9 (0.9, 0.9)
Maternal race/ethnicity							
Non-Hispanic White	63.4	1.0	1.0	1.0	1.0	1.0	1.0
Black	8.6	1.6	1.5 (1.5, 1.6)	1.9	1.9 (1.8, 2.0)	1.5	1.4 (1.4, 1.5)
Hispanic	6.6	1.1	1.1 (1.1, 1.2)	1.2	1.3 (1.1, 1.4)	1.1	1.1 (1.0, 1.1)
Asian	1.9	0.7	0.8 (0.7, 0.8)	0.8	0.8 (0.6, 0.9)	0.7	0.8 (0.7, 0.9)
Unknown/other	19.6	1.2	1.1 (1.1, 1.2)	1.3	1.3 (1.2, 1.3)	1.1	1.1 (1.1, 1.1)
Insurance							
Private	70.2	1.0	1.0	1.0	1.0	1.0	1.0
Public	27.3	1.2	0.9 (0.9, 1.0)	1.1	0.9 (0.8, 0.9)	1.2	1.0 (0.9, 1.0)
Self-pay	2.6	1.0	0.9 (0.8, 0.9)	1.0	0.9 (0.8, 1.0)	1.0	0.9 (0.8, 0.9)
Urban/rural county							
Large central counties of metro area > 1 million pop	15.3	1.0	1.0 (0.9, 1.0)	1.1	1.0 (1.0, 1.1)	1.0	0.9 (0.9, 1.0)
Large fringe counties of metro area > 1 million pop	44.0	1.0	1.0	1.0	1.0	1.0	1.0
Medium metro: pop 250,00–999,999	21.7	1.1	1.1 (1.1, 1.1)	1.3	1.3 (1.2, 1.3)	1.1	1.0 (1.0, 1.1)
Small metro: pop 50,000–249,999	6.0	1.1	1.1 (1.1, 1.2)	1.1	1.2 (1.1, 1.3)	1.1	1.1 (1.0, 1.2)

	% of all births	Aggregated		Severe/eclampsia		Mild	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Micropolitan counties	9.7	1.0	1.0 (1.0, 1.1)	1.1	1.2 (1.1, 1.3)	1.0	1.0 (0.9, 1.0)
Non-core counties	3.3	1.2	1.2 (1.2, 1.3)	1.1	1.2 (1.1, 1.4)	1.3	1.2 (1.1, 1.3)

[a]Mutually adjusted for all other variables in the table

Table 7

Predictors of aggregated preeclampsia, severe preeclampsia/eclampsia, and mild preeclampsia in New York City, 1995–2004

	% of all births	Aggregated		Severe/eclampsia		Mild	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
Total number of births (#, %)	788,454	35,048 (3.68)		8,316 (0.87)		26,732 (2.83)	
Year							
1995–1998	35.4	1.0	1.0	1.0	1.0	1.0	1.0
1999–2001	30.1	0.9	0.9 (0.9, 1.0)	1.0	1.1 (1.0, 1.1)	0.9	0.9 (0.9, 0.9)
2002–2004	34.6	0.9	0.9 (0.9, 0.9)	1.0	1.0 (1.0, 1.1)	0.9	0.9 (0.8, 0.9)
Maternal age (years)							
< 20	9.2	1.8	1.1 (1.0, 1.1)	1.4	0.8 (0.8, 0.9)	2.0	1.1 (1.1, 1.2)
20–24	22.4	1.2	0.9 (0.9, 1.0)	1.0	0.8 (0.8, 0.9)	1.3	1.0 (0.9, 1.0)
25–29	26.5	1.0	1.0	1.0	1.0	1.0	1.0
30–34	24.9	1.0	1.1 (1.1, 1.1)	1.0	1.1 (1.0, 1.2)	1.0	1.1 (1.1, 1.1)
≥35	17.0	1.2	1.5 (1.4, 1.6)	1.3	1.6 (1.4, 1.7)	1.2	1.5 (1.4, 1.6)
Maternal race/ethnicity							
Non-Hispanic White	23.3	1.0	1.0	1.0	1.0	1.0	1.0
Black	21.7	1.9	1.6 (1.5, 1.7)	2.0	1.9 (1.8, 2.1)	1.9	1.5 (1.5, 1.6)
Hispanic	20.0	1.7	1.6 (1.5, 1.7)	1.8	1.8 (1.7, 2.0)	1.7	1.5 (1.5, 1.6)
Asian	8.2	0.7	0.8 (0.7, 0.8)	0.7	0.7 (0.6, 0.8)	0.7	0.8 (0.7, 0.8)
Unknown/other	26.7	1.4	1.3 (1.3, 1.4)	1.6	1.6 (1.5, 1.8)	1.4	1.2 (1.2, 1.3)
Insurance							
Private	41.9	1.0	1.0	1.0	1.0	1.0	1.0
Public	54.7	1.3	1.2 (1.2, 1.3)	1.2	1.2 (1.1, 1.3)	1.4	1.3 (1.2, 1.3)
Self-pay	3.4	1.2	1.2 (1.1, 1.2)	1.1	1.1 (1.0, 1.3)	1.2	1.2 (1.1, 1.3)
Parity							
0	45.3	1.0	1.0	1.0	1.0	1.0	1.0
1	30.4	0.5	0.4 (0.4, 0.4)	0.5	0.5 (0.4, 0.5)	0.5	0.4 (0.4, 0.4)
≥2	24.3	0.5	0.4 (0.3, 0.4)	0.6	0.4 (0.4, 0.4)	0.5	0.3 (0.3, 0.4)
Maternal education (years)							
< 12	24.9	1.1	1.1 (1.1, 1.1)	1.1	1.0 (1.0, 1.1)	1.1	1.1 (1.1, 1.2)

	% of all births	Aggregated		Severe/eclampsia		Mild	
		Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)	Crude OR	Adjusted[a] OR (95 % CL)
12	32.8	1.0	1.0	1.0	1.0	1.0	1.0
13–16	31.5	1.0	0.9 (0.9, 1.0)	1.0	0.9 (0.8, 0.9)	1.0	0.9 (0.9, 1.0)
> 16	10.9	0.7	0.7 (0.7, 0.8)	0.8	0.7 (0.7, 0.8)	0.7	0.7 (0.7, 0.8)
Prenatal smoking							
No	96.8	1.0	1.0	1.0	1.0	1.0	1.0
Yes	3.2	0.8	0.8 (0.8, 0.9)	0.8	0.8 (0.7, 0.9)	0.9	0.8 (0.8, 0.9)
Prenatal care							
None or started in 3rd trimester	7.7	1.0	0.9 (0.9, 1.0)	1.0	0.9 (0.8, 1.0)	1.1	0.9 (0.9, 1.0)
Started 1st trimester	66.8	1.0	1.0	1.0	1.0	1.0	1.0
Started 2nd trimester	25.5	1.0	0.9 (0.9, 1.0)	0.9	0.9 (0.8, 1.0)	1.0	0.9 (0.9, 1.0)
Pre-pregnancy weight quintiles (lbs)							
≤118	21.5	1.0	1.0	1.0	1.0	1.0	1.0
> 118 to ≤130	23.0	1.2	1.2 (1.1, 1.2)	1.2	1.2 (1.1, 1.3)	1.2	1.2 (1.2, 1.3)
> 130 to ≤142	16.0	1.3	1.4 (1.3, 1.4)	1.3	1.2 (1.1, 1.4)	1.4	1.4 (1.3, 1.5)
> 142 to ≤165	20.8	1.6	1.7 (1.6, 1.8)	1.4	1.4 (1.3, 1.6)	1.7	1.8 (1.7, 1.9)
> 165	18.7	2.3	2.4 (2.3, 2.5)	1.8	1.8 (1.6, 1.9)	2.4	2.6 (2.5, 2.8)

[a] Mutually adjusted for all other variables in the table