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Effect of Parity on Pregnancy-Associated Hypertension Among Asian American Women in the United States

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Abstract

Objectives Pregnancy-associated hypertension (PAH) includes gestational hypertension, preeclampsia and eclampsia. Although a protective effect of multi-parity on PAH has been reported in previous studies, the association has not been examined among Asian American women in the U.S.

Methods Using data from 2014 U.S. National Vital Statistics System, we examined the prevalence of PAH among Asian American women who had singleton live births (N = 235,303), and its association with parity (number of previous pregnancies including live births and fetal deaths) controlling for potential confounders. We estimated adjusted odds ratios (aORs) and 95% confidence intervals (CI) using multivariable logistic regression analysis.

Results Overall, 2.72% (95% CI 2.66%, 2.79%) of Asian American women were recorded to have PAH during pregnancy. Parity was inversely associated with PAH in our study, where Asian American women who had 1–2 and 3 or more previous pregnancies had significantly lower odds of PAH (aOR 0.61, 95% CI 0.58, 0.65; and aOR 0.62, 95% CI 0.57, 0.68, respectively) compared to nulliparous women, after controlling for potential confounders.

Conclusions Recent U.S. vital statistics data revealed that nulliparity is significantly associated with PAH among Asian American women. Future studies should identify specific factors that are associated with PAH and factors contributing to disparities in PAH risk among Asian American women.

Keywords Parity · Pregnancy-associated hypertension · Asian American · Risk factors · Maternal health

Significance

Our study was aimed to investigate the association between parity and pregnancy-associated hypertension among Asian American women who delivered singleton livebirths in the U.S. Findings from our study add to the literature of gestational hypertensive disease among Asian Americans.

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Introduction

Hypertensive disorder of pregnancy (HDP) is one of the three main causes of maternal mortality in global population and contributes to nearly 15% of deaths (Say et al. 2014). As recommended by the National High Blood Pressure Education Program Working Group on High Blood Pressure in Pregnancy, HDPs are classified into four categories: (1) chronic hypertension, (2) preeclampsia-eclampsia, (3) preeclampsia superimposed on chronic hypertension, and (4) gestational hypertension (Mammaro et al. 2009). The incidence of severe preeclampsia is increasing worldwide (Lisonkova and Joseph 2013), and preeclampsia is annually accountable for approximately 60,000 maternal deaths worldwide (Zeeman 2009). In the United States, HDPs represent the most significant complication of pregnancy and affect about 10% of all pregnancies. Overall, 10% to 15% of maternal deaths are associated with preeclampsia and eclampsia (Jim et al. 2010). Since gestational hypertension, preeclampsia and eclampsia have similar risk factors and are also important markers for future development of metabolic syndrome and cardiovascular diseases (Gold et al. 2014), pregnancy-associated hypertension (PAH) which includes these three medical conditions may be a useful indicator.

Parity refers to the number of previous pregnancies resulting in live birth or fetal death, with a gestational time of greater than 20 weeks (Bai et al. 2002). Since dramatic alterations in the hormonal milieu and body morphology during pregnancy may have detrimental effects on the body (Lao et al. 2006), the association between parity and maternal health has been a concern for decades. In some studies, associations have been found between parity and adverse pregnancy outcomes (Ananth et al. 1996; Fuchs et al. 1985); while other studies indicated that multi-parity was not a risk for adverse pregnancy outcomes (Goldman et al. 1995; Toohey et al. 1995). There may be a number of reasons for the inconsistent study results, such as the limited sample size, failure to adjust for potential confounders (e.g., socioeconomic status), and different study populations. Female hormones, which change significantly during pregnancy, can affect the cardiovascular system, especially blood pressure(Kristiansson and Wang 2001). Though short-term change in hormones may lead to long-term effect on the cardiovascular system (Gunderson et al. 2008), previous studies indicate inconsistent effect of parity on hypertension in later life across different races and age groups (Giubertoni et al. 2013; Jang et al. 2015; Khalid 2006; Lupton et al. 2013; Taylor et al. 2008).

A study by Ayala and Hermida in Spain reported that multiparous women under 36 years old had insignificantly lower blood pressures than nulliparous women during different trimesters of pregnancy, while blood pressure was significantly higher among multiparous women over 36 years old compared to nulliparous women (Ayala and Hermida 2001). In a systematic review of studies from Saudi Arabia, Taiwan and the State of Washington in the US, Duckitt et al. identified nulliparity as a risk factor for pre-eclampsia (pooled relative risk: 2.91, 95% CI 1.28, 6.61) together with pre-existing diabetes, family history of hypertension, raised body mass index before pregnancy, and maternal age greater than 40 years (Duckitt and Harrington 2005). In Iceland, prevalence of pregnancy-induced hypertension among multiparous women was 5.5% lower compared to nulliparous women (Gunnlaugsson et al. 1989). A case-control study from Norway identify nulliparity (aOR 3.6, 95% CI 2.6, 5.0) as a risk factor for pre-eclampsia (Odegård et al. 2000).

In spite of their higher socioeconomic status compared to other races and ethnic groups in the U.S., Asian Americans experience higher prevalence of maternal morbidity and mortality (Siddiqui et al. 2017). Asian Americans are the fastest growing ethnic group in the U.S. and it is important to understand their health needs and outcomes. Using data from the 2014 U.S. vital records, we examined whether higher parity is associated with lower odds of PAH; and explored maternal characteristics associated with PAH among Asian American women residing in the U.S.

Methods

Data Source

We used the U.S. National Vital Statistics System data on all live births during the year 2014. These data are compiled from birth certificates and vital registration systems that are maintained and operated in the 50 States, two cities (Washington, DC, and New York City), and five territories (Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands) and are representative of over 95% of all births in the U.S. The Center for Disease Control and Prevention (CDC) National Center for Health Statistics (NCHS) collects and compiles the vital data, which has been prepared from individual records processed by regression area. Our study was limited to Asian American women who were residing in the U.S. and who had singleton live births during the year 2014.

Outcome Variable

PAH was ascertained based on a question on the birth certificate about presence or absence of PAH. The information concerning PAH status was collected directly from medical records and coded as ‘Yes’, ‘No’, ‘Unknown’, or ‘Blank (not on the certificate)’. For our analysis, women whose PAH information was coded as “Unknown” or left blank were excluded.

Exposure Variable

Parity indicates how many births (including live births and fetal deaths) a woman has had before the birth that was included in the study. Parity was assessed using total birth order, which refers to the number that the present birth represents. The original coding of total birth order in the birth certificates was ‘1’–‘7’ as number of total birth order, ‘8’ as 8 or more total births, and ‘9’ as unknown or not stated. For our analysis, we coded parity based on total birth orders: ‘0’ if total birth order is 1; ‘1–2’ if total birth order is 2–3; and ‘3 or more’ if total birth order is 4 or more. Unknown or not stated responses for parity were excluded.

Co-variables

We examined several co-variables, including maternal age in years (<25, 25–34, ≥ 35), Asian ethnic subgroup (Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian), Hispanic origin (Hispanic, Non-Hispanic), born in the U.S. (Yes, No), marital status (Married, Unmarried), education in years (< 12, 12, > 12), interval since last live birth in years (< 2, 2–4, ≥ 5), prenatal care initiation (No prenatal care, 1st trimester, 2nd trimester, 3rd trimester), peri-conceptional smoking (Yes, No), pre-pregnancy body mass index (BMI) (kg/m^2) (< 18.5, 18.5–24.9, 25.0–29.9, ≥ 30), weight gain during pregnancy in pounds (< 21, 21–40, 41–98), sex of infant (Female, Male), gestation age in weeks (< 37, ≥ 37), payment source for delivery (Medicaid, Private insurance, Self-pay, Other), and pre-pregnancy diabetes (Yes, No). Co-variables were identified based on the literature review (Duckitt and Harrington 2005; Franco et al. 2015; Gold et al. 2014; Macdonald-Wallis et al. 2013; Moon and Odibo 2015; Nakagawa et al. 2016).

Statistical Analysis

We examined the prevalence of PAH among all eligible women and estimated it as total number of women who were noted to have PAH on the birth certificate divided by all eligible women in the study. We compared demographic, maternal and infant characteristics among women with and without PAH. Even though our study population represented all Asian American women among the target population in the U.S. who delivered in year 2014, we followed the recommendation of The National Center for Health Statistics that annual vital statistics data used for analytic purposes could be considered as constituting a sample drawn from a broader population (MacDorman and Atkinson 1998); we thus calculated *P* values and reported 95% confidence intervals (CI). We used logistic regression to estimate the odds ratio (OR) quantifying the association between parity and PAH. Based on the variance inflation factor, we found no evidence of multicollinearity among explanatory variables selected for our analysis. Co-variables that were significantly associated with both parity and PAH were selected in the multivariable regression model together with all two-way interaction terms involving parity and co-variables. We computed adjusted odds ratios (aORs) and corresponding 95% CI. Different models were examined including full, reduced and *a priori* variable selection criteria. Backward logistic regression was used to identify the most parsimonious model. Co-variables selected in *a priori* model were determined based on literature review.

A two-sided *P* value of less than 0.05 was considered to indicate statistical significance. All statistical analyses were conducted using SAS® version 9.4 (SAS Institute Inc., Cary, NC). The study received a waiver from the Institutional Review Board at Emory University since all data were publicly available and void of personal identifiers.

Results

According to 2014 birth certificate data, a total of 235,303 Asian American women who were residents of the U.S. had singleton live births. Of those, 145 were excluded from our analysis due to missing information on PAH, 2714 due to missing information on parity, and 97 due to missing information on both PAH and parity. To assess selection bias, demographic characteristics were compared between included population and those who were excluded, and no significant differences were found. Thus, our study results were based on 232,347 births, constituting 98.7% of all births to Asian American women in the U.S. The distribution of sub-classes of Asian American race-ethnicity in our study showed 58,827 Asian Indian women (25.3%), 58,470 Chinese women (25.2%), 31,444 Filipino women (13.5%), 19,806 Vietnamese women (8.5%), 14,510 Korean women (6.2%), 6818 Japanese women (2.9%), and 42,472 women of other Asian ethnics (18.3%) (Table 1).

Of the 232,347 women examined in our study, 2.72% (95% CI 2.66%, 2.79%) reported having a diagnosis for PAH during pregnancy. The prevalence varied by different Asian American ethnicities, with 5.30% (95% CI 5.06%, 5.56%) among Filipino, 2.80% (95% CI 2.67%, 2.93%) among Asian Indian, 2.34% (95% CI 2.10%, 2.60%) among Korean, 2.21% (95% CI 2.02%, 2.43%) among Vietnamese, 2.19% (95% CI 1.86%, 2.56%) among Japanese, 1.41% (95% CI 1.31%, 1.51%) among Chinese, and 2.98% (95% CI 2.82%, 3.14%) among other Asian ethnic groups. Overall, women with and without PAH differed significantly on their parity (*P* value < .001) (Table 1). In the unadjusted analysis, women who had 1–2 previous pregnancies had lower odds of PAH (cOR 0.74, 95% CI 0.70, 0.78) compared to nulliparous women; however, the association did not persist among women who had three or more previous pregnancies (cOR 1.02, 95% CI 0.95, 1.11) (Table 1).

Results from a descriptive analysis of demographic, infant, and maternal characteristics, by three parity classes, are presented in Table 2.

In our multivariable analysis, we found an inverse association between multiparity and PAH. Our fully adjusted model showed a significant protective effect between parity and PAH, with 39% lower odds of having PAH during pregnancy among Asian American women who had 1–2 previous pregnancies (aOR 0.61, 95% CI 0.58, 0.65), and similarly, a 38% lower odds of PAH among those who had three or more previous pregnancies (aOR 0.62, 95% CI 0.57, 0.68) compared to nulliparous Asian American women, after adjusting for potential confounders (Table 3). The results from alternative reduced models were consistent with the results found in the fully adjusted statistical model (Table 3).

Table 1 Characteristics of Asian American women who had singleton births, by PAH status, 2014 U.S. births

Characteristics	PAH (N = 6326) n (%)	No PAH (N = 226,021) n (%)	Crude OR (95% CI)	*P* value[c]
Parity				<.001
0	2820 (44.6)	87,928 (38.9)	Referent	
1–2	2641 (41.7)	111,739 (49.4)	0.74 (0.70, 0.78)	
≥ 3	865 (13.7)	26,354 (11.7)	1.02 (0.95, 1.11)	
Maternal age (years)				<.001
< 25	528 (8.3)	22,030 (9.7)	0.96 (0.88, 1.06)	
25–34	3659 (57.8)	146,920 (65.0)	Referent	
≥ 35	2139 (33.8)	57,071 (25.3)	1.50 (1.43, 1.59)	
Asian ethnic subgroup				<.001
Asian Indian	1646 (26.0)	57,181 (25.3)	Referent	
Chinese	822 (13.0)	57,648 (25.5)	0.50 (0.46, 0.54)	
Filipino	1667 (26.4)	29,777 (13.2)	1.94 (1.81, 2.08)	
Japanese	149 (2.4)	6669 (3.0)	0.78 (0.66, 0.92)	
Korean	339 (5.4)	14,171 (6.3)	0.83 (0.74, 0.94)	
Vietnamese	438 (6.9)	19,368 (8.6)	0.79 (0.71, 0.87)	
Other Asian	1265 (20.0)	41,207 (18.2)	1.07 (0.99, 1.15)	
Hispanic origin				<.001
Hispanic	215 (3.4)	4752 (2.1)	1.66 (1.44, 1.90)	
Non-Hispanic	5940 (93.9)	217,523 (96.2)	Referent	
Born in the US				<.001
Yes	1590 (25.1)	41,728 (18.5)	Referent	
No	4713 (74.5)	183,426 (81.2)	0.67 (0.64, 0.71)	
Marital status				<.001
Married	5276 (83.4)	194,247 (85.9)	Referent	
Unmarried	1050 (16.6)	31,774 (14.1)	1.22 (1.14, 1.30)	
Education (years)				0.002
< 12	425 (6.7)	17,932 (7.9)	0.82 (0.73, 0.92)	
12	839 (13.3)	28,980 (12.8)	Referent	
>12	4833 (76.4)	172,528 (76.3)	0.97 (0.90, 1.04)	
Interval since last live birth (years)				
No previous live birth	3469 (54.8)	103,827 (46.0)	1.84 (1.66, 2.04)	<.001
1	399 (6.3)	21,967 (9.7)	Referent	
2–4	1154 (18.2)	58,356 (25.8)	1.09 (0.97, 1.22)	
≥ 5	1079 (17.1)	33,268 (14.7)	1.79 (1.59, 2.01)	
Prenatal care initiation				<.001
No prenatal care	53 (0.8)	1496 (0.7)	1.25 (0.95, 1.65)	
1st trimester	4955 (78.3)	174,935 (77.4)	Referent	
2nd trimester	913 (14.4)	32,395 (14.3)	1.00 (0.93, 1.07)	
3rd trimester	207 (3.3)	10,006 (4.4)	0.73 (0.63, 0.84)	
Periconceptional smoking[a]				<.001
Yes	136 (2.1)	2945 (1.3)	1.66 (1.40, 1.98)	
No	5993 (94.7)	215,645 (95.4)	Referent	
Pre-pregnancy BMI (kg/m^2)				<.001
Underweight (<18.5)	225 (3.6)	18,586 (8.2)	0.60 (0.52, 0.69)	
Normal weight (18.5–24.9)	2776 (43.9)	137,666 (60.9)	Referent	
Overweight (25.0–29.9)	1806 (28.5)	42,435 (18.8)	2.11 (1.99, 2.24)	
Obese (≥ 30)	1262 (19.9)	16,025 (7.1)	3.91 (3.65, 4.18)	
Weight gain during pregnancy (pounds)				<.001

Table 1 (continued)

Characteristics	PAH (N = 6326) n (%)	No PAH (N = 226,021) n (%)	Crude OR (95% CI)	*P* value[c]
< 21	1584 (25.0)	53,599 (23.7)	Referent	
21–40	3340 (52.8)	132,813 (58.8)	0.85 (0.80, 0.90)	
41–98	1103 (17.4)	28,474 (12.6)	1.31 (1.21, 1.42)	
Sex of infant				0.78
Female	3054 (48.3)	109,520 (48.5)	Referent	
Male	3272 (51.7)	116,501 (51.5)	1.00 (0.96, 1.06)	
Gestation age (weeks)				<.001
Preterm (<37)	1394 (22.0)	17,247 (7.6)	3.42 (3.22, 3.64)	
Term (≥ 37)	4930 (77.9)	208,659 (92.3)	Referent	
Payment source for delivery				<.001
Medicaid	1628 (25.7)	59,209 (26.2)	0.91 (0.86, 0.97)	
Private insurance	4208 (66.5)	139,578 (61.8)	Referent	
Self-pay	204 (3.2)	17,786 (7.9)	0.38 (0.33, 0.44)	
Other[2]	227 (3.6)	7257 (3.2)	1.04 (0.91, 1.19)	
Pre-pregnancy diabetes				<.001
Yes	155 (2.5)	1390 (0.6)	4.06 (3.43, 4.80)	
No	6159 (97.4)	224,116 (99.2)	Referent	

Frequency may not equal total due to missing data. Percentages may not be equal to 100 because of missing data

PAH pregnancy-associated hypertension, *BMI* body mass index, *US* United States

[a]Periconceptional smoking indicates smoking status between 3 months before conception to 3 months after conception

[b]Other includes Indian Health Service, CHAMPUS/TRICARE, Other government and other sources

[c]Chi square tests were performed to compare the two groups

PAH was also significantly associated older maternal age, Filipino ethnicity, higher pre-pregnancy BMI, higher weight gain during pregnancy, preterm birth, and pre-pregnancy diabetes. Being born out of the U.S. and self-paying for delivery were significantly inversely associated with PAH (Table 3).

Discussion

Based on 2014 U.S. birth certificate data from the National Vital Statistics System, we found that the overall prevalence of PAH among Asian American women was 2.72%. Notably, Filipino American reported a PAH prevalence of 5.30%, which was the highest among all Asian American ethnic subgroups. With regards to parity, PAH prevalence is 3.11% among all Asian American women who were nulliparous, 2.31% among those who had 1–2 previous pregnancies, 3.18% among those who had 3 or more previous pregnancies. Our study found that multiparity was inversely associated with PAH among Asian American women.

Our findings on the association between multiparity and PAH among Asian American women are consistent with those from previous studies that were based on other populations (Gold et al. 2014; Gunnlaugsson et al. 1989; Odegård et al. 2000; Strevens et al. 2001). In a case-control study based on Norwegian population, nulliparity showed a stronger effect on PAH (aOR 3.6, 95% CI 2.6–5.0) compared to what we reported; the difference in the association might be explained by the disparity of inherent characteristics, years in which the data were collected and the nature of covariates that were controlled during analysis (Odegård et al. 2000). The magnitude of association between parity and PAH noted in our study could not be directly compared with previous studies due to methodological differences. However, our study generated similar results with those studies in terms of prevalence or incidence of PAH across parity groups where prevalence of PAH was always higher among nulliparous women compared to multiparous women (Gold et al. 2014; Gunnlaugsson et al. 1989; Odegård et al. 2000; Strevens et al. 2001).

Besides parity, our study also found several maternal characteristics to be associated with PAH among Asian Americans. Odds of PAH were observed to be higher in older groups of Asian American women, similar association was reported among other races in the U.S. (Gold et al. 2014). In our study, women who were overweight or obese before pregnancy were twice more likely to experience PAH

Table 2 Characteristics of Asian American women who had singleton births, by parity categories, 2014 US births

Characteristics	Parity category			
	0 (N = 90,748) n (%)	1–2 (N = 114,380) n (%)	≥ 3 (N = 27,219) n (%)	*P* value[c]
PAH				<.001
Yes	2820 (3.1)	2641 (2.3)	865 (3.2)	
No	87,928 (96.9)	111,739 (97.7)	26,354 (96.8)	
Maternal age (years)				<.001
< 25	13,733 (15.1)	7809 (6.8)	1016 (3.7)	
25–34	63,908 (70.4)	72,838 (63.7)	13,833 (50.8)	
≥ 35	13,107 (14.4)	33,733 (29.5)	12,370 (45.4)	
Asian ethnic subgroup				<.001
Asian Indian	24,932 (27.5)	28,753 (25.1)	5142 (18.9)	
Chinese	24,071 (26.5)	29,325 (25.6)	5074(18.6)	
Filipino	11,297 (12.4)	15,830 (13.8)	4317 (15.9)	
Japanese	2703 (3.0)	3428 (3.0)	687 (2.5)	
Korean	6082 (6.7)	7048 (6.2)	1380 (5.1)	
Vietnamese	7351 (8.1)	10,115 (8.8)	2340 (8.6)	
Other Asian	14,312 (15.8)	19,881 (17.4)	8279 (30.4)	
Hispanic origin				<.001
Hispanic	1598 (1.8)	2329 (2.0)	1040 (3.8)	
Non-Hispanic	87,555 (96.5)	110,252 (96.4)	25,656 (94.3)	
Born in the US				<.001
Yes	17,555 (19.3)	20,078 (17.6)	5685 (20.9)	
No	72,852 (80.3)	93,905 (82.1)	21,382 (78.6)	
Marital status				<.001
Married	77,173 (85.0)	100,398 (87.8)	21,952 (80.6)	
Unmarried	13,575 (15.0)	13,982 (12.2)	5267 (19.4)	
Education (years)				<.001
< 12	4932 (5.4)	9156 (8.0)	4269 (15.7)	
12	9527 (10.5)	15,170 (13.3)	5122 (18.8)	
>12	73,547 (81.0)	86,834 (75.9)	16,980 (62.4)	
Interval since last live birth (years)				
No previous live birth	90,515 (99.7)	15,604 (13.6)	1177 (4.3)	<.001
< 2	0 (0)	17,539 (15.3)	4827 (17.7)	
2–4	0 (0)	48,497 (42.4)	11,013 (40.5)	
≥ 5	0 (0)	26,310 (23.0)	8037 (29.5)	
Prenatal care initiation				<.001
No prenatal care	641 (0.7)	610 (0.5)	296 (1.1)	
1st trimester	70,532 (77.7)	89,599 (78.3)	19,759 (72.6)	
2nd trimester	12,269 (13.5)	15,926 (13.9)	5113 (18.8)	
3rd trimester	4226 (4.7)	4755 (4.2)	1232 (4.5)	
Periconceptional smoking[a]				<.001
Yes	1020 (1.1)	1335 (1.2)	726 (2.7)	
No	86,752 (95.6)	109,104 (95.4)	25,782 (94.7)	
Pre-pregnancy BMI (kg/m^2)				<.001
Underweight (<18.5)	9130 (10.1)	8406 (7.3)	1275 (4.7)	
Normal weight (18.5–24.9)	57,543 (63.4)	68,494 (59.9)	14,405 (52.9)	
Overweight (25.0–29.9)	14,385 (15.9)	23,020 (20.1)	6836 (25.1)	
Obese (≥ 30)	5034 (5.5)	8753 (7.7)	3500 (12.9)	
Weight gain during pregnancy (pounds)a				<.001

Table 2 (continued)

Characteristics	Parity category			
	0 (N = 90,748) n (%)	1–2 (N = 114,380) n (%)	≥ 3 (N = 27,219) n (%)	*P* value[c]
< 21	17,907 (19.7)	28,616 (25.0)	8660 (31.8)	
21–40	54,373 (59.9)	67,383 (58.9)	14,397 (52.9)	
41–98	14,013 (15.4)	12,681 (11.1)	2883 (10.6)	
Sex of infant				0.01
Female	44,334 (48.9)	55,166 (48.2)	13,074 (48.0)	
Male	46,414 (51.1)	59,214(51.8)	14,145 (52.0)	
Gestational age (weeks)				<.001
Preterm (< 37)	7007 (7.7)	8743 (7.6)	2891 (10.6)	
Term (≥ 37)	83,700 (92.2)	105,575(92.3)	24,314 (89.3)	
Payment source for delivery				<.001
Medicaid	20,418 (22.5)	29,813 (26.1)	10,606 (39.0)	
Private insurance	59,479 (65.5)	70,566 (61.7)	13,741 (50.5)	
Self-pay	7035 (7.8)	9249 (8.1)	1706 (6.3)	
Other[b]	2858 (3.1)	3719 (3.3)	907 (3.3)	
Pre-pregnancy diabetes				<.001
Yes	419 (0.5)	795 (0.7)	331 (1.2)	
No	90,096 (99.3)	113,350 (99.1)	26,829 (98.6)	

Frequency may not equal total due to missing data. Percentages may not be equal to 100 because of missing data

PAH pregnancy-associated hypertension, *BMI* body mass index

[a]Periconceptional smoking indicates smoking status between 3 months before conception to 3 months after conception

[b]Other includes Indian Health Service, CHAMPUS/TRICARE, Other government and other sources

[c]Chi square tests were performed to compare the two groups

compared to women of normal BMI, and this results is consistent with previous literature (Duckitt and Harrington 2005). Additionally, pre-pregnancy diabetes, preterm birth and having a weight gain during pregnancy were significant predictors of PAH in our study, as well as other studies in the past (Macdonald-Wallis et al. 2013; Steegers et al. 2010).

In our research, Asian American women who were born out of the U.S. were significantly less likely to have PAH compared to those born in the U.S. This weak protective effect of being born out of the U.S. against PAH could not be explained. We recommend studying this phenomenon further, while accounting for the length of stay in the U.S. and acculturation among women who are non-U.S. natives.

We examined payment source for delivery as an indicator of socio-economic status. Women who used their own money instead of Medicaid or private insurance to pay for delivery were less likely to have PAH. Most notably, Filipino women had significantly higher odds of PAH compared with Asian Indian women, while other Asian ethnic subgroups all had lower odds than Asian Indian. The disparity in PAH risk across different Asian ethnic groups indicate heterogeneity among different ethnicities of Asian Americans. The prevalence of PAH among Filipino women was 5.3% which was the highest among all Asian ethnic subgroups and nearly twice the PAH prevalence among all Asian American women in this study. In 2014, the prevalence of PAH for all American women, non-Hispanic white and non-Hispanic black were 5.3, 5.3 and 6.4% respectively ("CDC WONDER" 2019). In comparison, PAH was rarer among Asian women than non-Hispanic Black and Non-Hispanic White women in the U.S.

Our study has several strengths. Since more than 99% of births occurring in the U.S. are registered (Steegers et al. 2010), our study nearly included the whole population of interest. Second, NCHS collects information from U.S. Standard Certificate of Live Birth. Thus, parity, PAH and other gestational medical conditions reported in the birth certificate are abstracted directly from medical records, prior to delivery of index child, Third, since birth certificates report information on various demographic and maternal health history variables, we could control for several potential confounders. We were also able to examine our hypothesis among different strata of Asian ethnicity.

The main limitation of this study would be the inability to study the association between parity and PAH among women who had a miscarriage or still birth during index

Table 3 Logistic regression analysis examining the association between parity and PAH among Asian American women who had singleton births, 2014 US births

Characteristics	cOR (95% CI)	Full model[a] aOR (95% CI)	Reduced model[b] aOR (95% CI)	*A Priori* model[c] aOR (95% CI)
Parity				
0	Referent	Referent	Referent	Referent
1–2	0.74 (0.70, 0.78)	0.61 (0.58, 0.65)	0.61 (0.57, 0.64)	0.60 (0.57, 0.64)
≥3	1.02 (0.95, 1.11)	0.62 (0.57, 0.68)	0.62 (0.57, 0.68)	0.63 (0.58, 0.69)
Maternal age (years)				
<25	0.96 (0.88, 1.06)	0.73 (0.66, 0.82)	0.77 (0.69, 0.85)	0.75 (0.68, 0.84)
25–34	Referent	Referent	Referent	Referent
≥ 35	1.50 (1.43, 1.59)	1.61 (1.51, 1.71)	1.56 (1.47, 1.65)	1.63 (1.54, 1.73)
Asian ethnic subgroup				
Asian Indian	Referent	Referent	Referent	Referent
Chinese	0.50 (0.46, 0.54)	0.68 (0.62, 0.75)	0.70 (0.64, 0.76)	0.66 (0.61, 0.73)
Filipino	1.94 (1.81, 2.08)	1.70 (1.58, 1.84)	1.79 (1.67, 1.93)	1.79 (1.67, 1.93)
Japanese	0.78 (0.66, 0.92)	0.83 (0.69, 1.00)	0.85 (0.72, 1.01)	0.80 (0.67, 0.96)
Korean	0.83 (0.74, 0.94)	0.92 (0.81, 1.05)	0.94 (0.83, 1.06)	0.90 (0.80, 1.02)
Vietnamese	0.79 (0.71, 0.87)	0.93 (0.83, 1.05)	0.97 (0.86, 1.08)	0.96 (0.86, 1.08)
Other Asian	1.07 (0.99, 1.15)	1.08 (0.99, 1.18)	1.09 (1.00, 1.18)	1.07 (0.99, 1.16)
Hispanic origin				
Hispanic	1.66 (1.44, 1.90)	1.12 (0.95, 1.31)	NA	NA
Non-Hispanic	Referent	Referent		
Born in the US				
Yes	Referent	Referent	NA	Referent
No	0.67 (0.64, 0.71)	0.91 (0.85, 0.97)		0.87 (0.81, 0.92)
Marital status				
Married	Referent	Referent	NA	NA
Unmarried	1.22 (1.14, 1.30)	1.00 (0.92, 1.08)		
Education (years)				
<12	0.82 (0.73, 0.92)	0.86 (0.75, 0.97)	NA	NA
12	Referent	Referent		
>12	0.97 (0.90, 1.04)	0.93 (0.85, 1.02)		
Prenatal care initiation				
No prenatal care	1.25 (0.95, 1.65)	0.98 (0.70, 1.39)	NA	NA
1st trimester	Referent	Referent		
2nd trimester	1.00 (0.93, 1.07)	0.98 (0.91, 1.06)		
3rd trimester	0.73 (0.63, 0.84)	0.87 (0.75, 1.02)		
Periconceptional smoking[d]				
Yes	1.66 (1.40, 1.98)	1.14 (0.94, 1.38)	NA	1.27 (1.06, 1.52)
No	Referent	Referent		Referent
Pre-pregnancy BMI (kg/m^2)				
Underweight (<18.5)	0.60 (0.52, 0.69)	0.65 (0.56, 0.75)	0.66 (0.58, 0.76)	0.68 (0.59, 0.78)
Normal weight (18.5–24.9)	Referent	Referent	Referent	Referent
Overweight (25.0–29.9)	2.11 (1.99, 2.24)	2.01 (1.88, 2.15)	1.96 (1.84, 2.08)	1.97 (1.85, 2.10)
Obese (≥30)	3.91 (3.65, 4.18)	3.64 (3.37, 3.94)	3.43 (3.19, 3.69)	3.39 (3.16, 3.65)
Weight gain during pregnancy (pounds)				
< 21	Referent	Referent	NA	NA
21–40	0.85 (0.80, 0.90)	1.20 (1.12, 1.28)		
41–98	1.31 (1.21, 1.42)	1.93 (1.77, 2.11)		
Gestation age (weeks)				
Preterm (<37)	3.42 (3.22, 3.64)	3.14 (2.94, 3.36)	2.99 (2.80, 3.19)	NA

Table 3 (continued)

Characteristics	cOR (95% CI)	Full model[a] aOR (95% CI)	Reduced model[b] aOR (95% CI)	*A Priori* model[c] aOR (95% CI)
Term (≥ 37)	Referent	Referent	Referent	
Payment source for delivery				
Medicaid	0.91 (0.86, 0.97)	0.99 (0.92, 1.06)	0.99 (0.93, 1.05)	1.03 (0.96, 1.10)
Private insurance	Referent	Referent	Referent	Referent
Self-pay	0.38 (0.33, 0.44)	0.62 (0.52, 0.73)	0.62 (0.53, 0.72)	0.63 (0.54, 0.74)
Other[e]	1.04 (0.91, 1.19)	0.97 (0.84, 1.12)	0.97 (0.84, 1.11)	0.98 (0.85, 1.12)
Pre-pregnancy diabetes				
Yes	4.06 (3.43, 4.80)	2.07 (1.72, 2.49)	2.04 (1.70, 2.45)	2.27 (1.90, 2.72)
No	Referent	Referent	Referent	Referent

PAH pregnancy-associated hypertension, *BMI* body mass index, *cOR* Crude Odds Ratio, *aOR* Adjusted Odds Ratio, *CI* Confidence interval

[a]Full model includes parity, maternal age, Asian ethnic subgroup, Hispanic origin, whether born in the US, marital status, education, prenatal care initiation, periconceptional smoking, pre-pregnancy BMI, weight gain during pregnancy, gestation age, payment source for delivery, and pre-pregnancy diabetes as independent variables

[b]Reduced model includes parity, maternal age, Asian ethnic subgroup, pre-pregnancy BMI, gestation age, payment source for delivery and pre-pregnancy diabetes as independent variables

[c]*A priori* model includes parity, maternal age, Asian ethnic subgroup, whether born in the US, periconceptional smoking, pre-pregnancy BMI, payment source for delivery, and pre-pregnancy diabetes as independent variables

[d]Periconceptional smoking indicates smoking status between 3 months before conception to 3 months after conception

[e]Other includes Indian Health Service, CHAMPUS/TRICARE, Other government and other sources

pregnancy. Birth certificates only include information of women who have live births. Since PAH is associated with higher risk of stillbirth and stillbirths occur in about 1% of all pregnancies in the U.S. (MacDorman and Gregory 2015), a fair number of PAH cases may have been missed by including only those who had live births. As such, our results are only generalizable to live births. In addition, some potential confounders were not controlled in this study. Published studies indicate that previous history of preeclampsia, family history of preeclampsia and some pre-existing medical conditions are also risk factors of PAH. In our study, only pre-existing diabetes was included as a pre-existing condition in analysis, other medical conditions like hypertension, renal disease and autoimmune diseases were not considered because of limited information on such variables in the database.

In conclusion, our study found that multiparity is significantly associated with lower odds of PAH among Asian American women residing in the U.S.; and Filipino American women are more likely to experience PAH than other Asian ethnic subgroups. Reduction of pre-pregnancy BMI, restriction of weight gain during pregnancy and positive control of pre-existing medical conditions can be recommended to Asian American women who are expectant mothers. Since our study indicates positive association between Filipino ethnicity and PAH, more frequent monitoring and counseling for hypertensive diseases should be directed towards this ethnic group. We recommend that future studies explore specific factors that are driving the disparities in PAH prevalence between Filipino and other ethnic subgroups of Asians living in the U.S.

Compliance with Ethical Standards

Conflict of interest The authors have declare that they have no conflict of interest.

References

Ananth, C. V., Wilcox, A. J., Savitz, D. A., Bowes, W. A., & Luther, E. R. (1996). Effect of maternal age and parity on the risk of uteroplacental bleeding disorders in pregnancy. *Obstetrics and Gynecology, 88*(4 Pt 1), 511–516.

Ayala, D. E., & Hermida, R. C. (2001). Influence of parity and age on ambulatory monitored blood pressure during pregnancy. *Hypertension, 38*(3 Pt 2), 753–758.

Bai, J., Wong, F. W., Bauman, A., & Mohsin, M. (2002). Parity and pregnancy outcomes. *American Journal of Obstetrics and Gynecology, 186*(2), 274–278.

CDC WONDER. (2019). Retrieved from https://wonder.cdc.gov/

Duckitt, K., & Harrington, D. (2005). Risk factors for pre-eclampsia at antenatal booking: Systematic review of controlled studies. *BMJ, 330*(7491), 565. https://doi.org/10.1136/bmj.38380.674340.E0.

Franco, R. C., Ferreira, C. R., Vieira, C. R., & Silva, R. R. (2015). Ethnicity, obesity and emotional factors associated with gestational hypertension. *Journal of Community Health, 40*(5), 899–904. https://doi.org/10.1007/s10900-015-0010-8.

Fuchs, K., Peretz, B. A., Marcovici, R., Paldi, E., & Timor-Tritsh, I. (1985). The “grand multipara”–is it a problem? A review of 5785 cases. *International Journal of Gynaecology and Obstetrics, 23*(4), 321–326.

Giubertoni, E., Bertelli, L., Bartolacelli, Y., Origliani, G., & Modena, M. G. (2013). Parity as predictor of early hypertension during menopausal transition. *Journal of Hypertension, 31*(3), 501–507. https://doi.org/10.1097/HJH.0b013e32835c1742. (**Discussion 507**).

Gold, R. A., Gold, K. R., Schilling, M. F., & Modilevsky, T. (2014). Effect of age, parity, and race on the incidence of pregnancy associated hypertension and eclampsia in the United States. *Pregnancy Hypertens, 4*(1), 46–53. https://doi.org/10.1016/j.pregh y.2013.10.001.

Goldman, G. A., Kaplan, B., Neri, A., Hecht-Resnick, R., Harel, L., & Ovadia, J. (1995). The grand multipara. *European Journal of Obstetrics, Gynecology, and Reproductive Biology, 61*(2), 105–109.

Gunderson, E. P., Chiang, V., Lewis, C. E., Catov, J., Quesenberry, C. P., Sidney, S., et al. (2008). Long-term blood pressure changes measured from before to after pregnancy relative to nonparous women. *Obstetrics and Gynecology, 112*(6), 1294–1302. https://doi.org/10.1097/AOG.0b013e31818da09b.

Gunnlaugsson, S. R., Geirsson, R. T., Snaedal, G., & Hallgrimsson, J. T. (1989). Incidence and relation to parity of pregnancy-induced hypertension in Iceland. *Acta Obstetricia et Gynecologica Scandinavica, 68*(7), 599–601.

Jang, M., Lee, Y., Choi, J., Kim, B., Kang, J., Kim, Y., et al. (2015). Association between parity and blood pressure in Korean women: Korean national health and nutrition examination survey, 2010–2012. *Korean Journal of Family Medicine, 36*(6), 341–348. https://doi.org/10.4082/kjfm.2015.36.6.341.

Jim, B., Sharma, S., Kebede, T., & Acharya, A. (2010). Hypertension in pregnancy: A comprehensive update. *Cardiology in Review, 18*(4), 178–189. https://doi.org/10.1097/CRD.0b013e3181c60ca6.

Khalid, M. E. (2006). The effect of age, obesity and parity on blood pressure and hypertension in non-pregnant married women. *Journal of Family and Community Medicine, 13*(3), 103–107.

Kristiansson, P., & Wang, J. X. (2001). Reproductive hormones and blood pressure during pregnancy. *Human Reproduction, 16*(1), 13–17.

Lao, X. Q., Thomas, G. N., Jiang, C. Q., Zhang, W. S., Yin, P., Schooling, M., et al. (2006). Parity and the metabolic syndrome in older Chinese women: The Guangzhou Biobank Cohort Study. *Clinical Endocrinology, 65*(4), 460–469. https://doi.org/10.1111/j.1365-2265.2006.02615.x.

Lisonkova, S., & Joseph, K. S. (2013). Incidence of preeclampsia: Risk factors and outcomes associated with early- versus late-onset disease. *American Journal of Obstetrics and Gynecology, 209*(6), 544.e541–544.e512. https://doi.org/10.1016/j.ajog.2013.08.019.

Lupton, S. J., Chiu, C. L., Lujic, S., Hennessy, A., & Lind, J. M. (2013). Association between parity and breastfeeding with maternal high blood pressure. *American Journal of Obstetrics and Gynecology, 208*(6), 454.e1–454.e7. https://doi.org/10.1016/j.ajog.2013.02.014.

Macdonald-Wallis, C., Tilling, K., Fraser, A., Nelson, S. M., & Lawlor, D. A. (2013). Gestational weight gain as a risk factor for hypertensive disorders of pregnancy. *American Journal of Obstetrics and Gynecology, 209*(4), 327.e1–327.e17. https://doi.org/10.1016/j.ajog.2013.05.042.

MacDorman, M. F., & Atkinson, J. O. (1998). Infant mortality statistics from the linked birth/infant death data set–1995 period data. *Monthly Vital Statistics Report, 46*(6 Suppl 2), 1–22.

MacDorman, M. F., & Gregory, E. C. (2015). Fetal and Perinatal Mortality: United States, 2013. *National Vital Statistics Reports, 64*(8), 1–24.

Mammaro, A., Carrara, S., Cavaliere, A., Ermito, S., Dinatale, A., Pappalardo, E. M., et al. (2009). Hypertensive disorders of pregnancy. *Journal of Prenatal Medicine, 3*(1), 1–5.

Moon, M., & Odibo, A. (2015). First-trimester screening for preeclampsia: impact of maternal parity on modeling and screening effectiveness. *Journal of Maternal-Fetal and Neonatal Medicine, 28*(17), 2028–2033. https://doi.org/10.3109/14767058.2014.978758.

Nakagawa, K., Lim, E., Harvey, S., Miyamura, J., & Juarez, D. T. (2016). Racial/ethnic disparities in the association between preeclampsia risk factors and preeclampsia among women residing in Hawaii. *Maternal and Child Health Journal, 20*(9), 1814–1824. https://doi.org/10.1007/s10995-016-1984-2.

Odegård, R. A., Vatten, L. J., Nilsen, S. T., Salvesen, K. A., & Austgulen, R. (2000). Risk factors and clinical manifestations of pre-eclampsia. *BJOG, 107*(11), 1410–1416.

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A. B., Daniels, J., et al. (2014). Global causes of maternal death: A WHO systematic analysis. *The Lancet Global Health, 2*(6), e323–e333. https://doi.org/10.1016/S2214-109X(14)70227-X.

Siddiqui, M., Minhaj, M., Mueller, A., Tung, A., Scavone, B., Rana, S., et al. (2017). Increased perinatal morbidity and mortality among Asian American and Pacific Islander women in the United States. *Anesthesia and Analgesia, 124,* 879–886. https://doi.org/10.1213/ANE.0000000000001778.

Steegers, E. A., von Dadelszen, P., Duvekot, J. J., & Pijnenborg, R. (2010). Pre-eclampsia. *Lancet, 376*(9741), 631–644. https://doi.org/10.1016/S0140-6736(10)60279-6.

Strevens, H., Wide-Swensson, D., & Ingemarsson, I. (2001). Blood pressure during pregnancy in a Swedish population; impact of parity. *Acta Obstetricia et Gynecologica Scandinavica, 80*(9), 824–829.

Taylor, J. Y., Chambers, A. N., Funnell, B., & Wu, C. Y. (2008). Effects of parity on blood pressure among African-American women. *The Journal of National Black Nurses Association, 19*(2), 12–19.

Toohey, J. S., Keegan, K. A., Morgan, M. A., Francis, J., Task, S., & deVeciana, M. (1995). The "dangerous multipara": Fact or fiction? *American Journal of Obstetrics and Gynecology, 172*(2 Pt 1), 683–686.

Zeeman, G. G. (2009). Neurologic complications of pre-eclampsia. *Seminars in Perinatology, 33*(3), 166–172. https://doi.org/10.1053/j.semperi.2009.02.003.