6-2015

Does maternal asthma contribute to racial/ethnic disparities in obstetric and neonatal complications?

Katrina F. Flores

Candace Robledo
The University of Texas Rio Grande Valley, candace.robledo@utrgv.edu

Beom Seuk Hwang

Kira Leishear

Katherine Grantz

See next page for additional authors

Recommended Citation

Flores, K. F., Robledo, C. A., Hwang, B. S., Leishear, K., Laughon Grantz, K., & Mendola, P. (2015). Does maternal asthma contribute to racial/ethnic disparities in obstetrical and neonatal complications?. Annals of epidemiology, 25(6), 392–397.e1. https://doi.org/10.1016/j.annepidem.2015.01.011

HHS Public Access

Author manuscript

Ann Epidemiol. Author manuscript; available in PMC 2016 June 01.

Published in final edited form as:

Ann Epidemiol. 2015 June ; 25(6): 392–397.e1. doi:10.1016/j.annepidem.2015.01.011.

Does maternal asthma contribute to racial/ethnic disparities in obstetric and neonatal complications?

Katrina F. Flores[a], **Candace A. Robledo**[a], **Beom Seuk Hwang**[b], **Kira Leishear**[c], **Katherine Laughon Grantz**[a], and **Pauline Mendola**[a]

[a]Epidemiology Branch, Division of Intramural Population Health Research, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, Rockville, Maryland 6100 Executive Blvd Rockville, MD 20852

[b]Biostatistics and Bioinformatics Branch, Division of Intramural Population Health Research, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, Rockville, Maryland 6100 Executive Blvd Room 7B05G, MSC 7510 Bethesda MD 20892-7510

[c]Food and Drug Administration, Center for Drug Evaluation and Research, Office of Surveillance and Epidemiology, Office of Pharmacovigilance and Epidemiology, Division of Epidemiology 10903 New Hampshire Ave Silver Spring, MD 20993

Abstract

Purpose—Examine whether maternal asthma contributes to racial/ethnic differences in obstetric and neonatal complications.

Methods—Data on White (n=110,603), Black (n=50,284) and Hispanic (n=38,831) singleton deliveries came from the Consortium on Safe Labor. Multi-level logistic regression models, with an interaction term for asthma and race/ethnicity, estimated within-group adjusted odds ratios (aOR) for gestational diabetes, gestational hypertension, preeclampsia, placental abruption, premature rupture of membranes, preterm delivery, maternal hemorrhage, NICU admissions, small for gestational age (SGA), apnea, respiratory distress syndrome, transient tachypnea of the newborn, anemia and hyperbilirubinemia after adjustment for clinical and demographic confounders. Non-asthmatics of the same racial/ethnic group were the reference group.

Results—Compared to non-asthmatics, White asthmatics had increased odds of preeclampsia (aOR 1.28; 95% CI: 1.15–1.43) and maternal hemorrhage (1.14; 1.04–1.23). White and Hispanic infants were more likely to have NICU admissions (1.19; 1.11–1.28; 1.16; 1.02–1.32, respectively) and be SGA (1.11; 1.02–1.20; 1.26; 1.10–1.44, respectively) and Hispanic infants were more likely to have apnea (1.32; 1.02–1.69).

Corresponding Author: Pauline Mendola, PhD, Epidemiology Branch, Division of Intramural Population Health Research, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, 6100 Executive Blvd, Room 7B03F, Rockville, MD 20852, Office (301) 496-5267, pauline.mendola@nih.gov.

Conclusions—Maternal asthma did not impact most obstetric and neonatal complication risks within racial/ethnic groups. Despite their increased risk for both asthma and many complications, our findings for Black women were null. Asthma did not contribute to racial/ethnic disparities in complications.

Keywords

asthma; pregnancy; infant; ethnic groups; health disparities

Introduction

Asthma is the most common chronic disease during pregnancy, complicating up to 12% of US pregnancies annually [1, 2]. Maternal asthma has been found to increase the risk of obstetric and neonatal complications such as preterm birth, preeclampsia, gestational diabetes, and low birth weight [1, 3–5]. Asthma also disproportionately affects certain racial/ethnic groups. For instance, Non-Hispanic Blacks have a higher prevalence of asthma compared with Whites (11.2% vs 7.7%), Hispanics (6.5%) or Asians (5.2%) [6].

Racial/ethnic disparities in maternal and neonatal morbidity and mortality are also well established and have been found to persist [7–9]. For instance, while infant mortality rates have declined in the US, the 2010 mortality rate for Black infants of 11.5 deaths per 1000 live births remains more than twice the rate reported for infants born to Non-Hispanic Whites (5.18), Hispanics (5.25) and Asian/Pacific Islanders (4.27) [10]. In addition, a multi-state analysis found rates of severe maternal morbidity per 10,000 delivery hospitalizations among Non-Hispanic Black (284.26) and American Indian/Alaska Native women (225.47) were much higher than among Non-Hispanic Whites (113.93) with intermediate rates observed for Hispanic (145.28) and Asian/Pacific Islander women (131.97) [11].

Examining the extent to which underlying racial/ethnic disparities in obstetric and neonatal outcomes may be attributed to maternal asthma could identify a key point for intervention to help reduce these persistent disparities. In addition, racial/ethnic disparities in obstetric and neonatal outcomes among women with asthma are understudied. One prior study examined the impact of maternal asthma on obstetric and neonatal outcomes by race/ethnicity, but this nation-wide US effort did not consider the underlying differences in outcome prevalence by race among women without asthma [12]. We addressed this gap in knowledge by examining the joint impact of maternal race/ethnicity and asthma on the odds of obstetric and neonatal complications.

Methods

Study Population

The Consortium on Safe Labor (CSL) was a retrospective cohort of US deliveries between 2002 and 2008 [13]. The CSL took place across 12 clinical sites (19 medical centers) covering nine American College of Obstetricians and Gynecologists (ACOG) districts. We obtained data on 223,512 singleton deliveries. For this analysis, participants were excluded if their race/ethnicity was listed as multi-racial (n = 343), other (n = 4,888) or was unknown/

missing (n = 9,382). Thus, our cohort for analysis consisted of 208,899 singleton deliveries, and included racial/ethnic groups of White (n = 110,603, 52.9%), Black (n = 50,284, 24.1%), Hispanic (n = 38,831, 18.3%) and Asian/Pacific Islanders (n = 9,181, 4.4%). Race/ethnicity was recorded in the EMR and is assumed to be self-reported. The reporting suggests that women of Hispanic ethnicity could be of any race. Most women contributed only one pregnancy (n = 191,071, 91.5%). Asthma status was based on *International Classification of Diseases, 9th edition (ICD-9)* codes or delivery records and participants could contribute deliveries to both groups if they were diagnosed with asthma between pregnancies. Institutional review board approval was obtained by all participating institutions.

Main Outcomes

Data on maternal demographics, medical history, obstetric and neonatal outcomes were obtained from electronic medical records (EMRs) supplemented with *International Classification of Diseases, 9th edition (ICD-9)* codes in hospital discharge summaries. Codes used to identify complications have been previously described [5, 14]. We evaluated neonatal and obstetric outcomes previously identified in our data as being associated with maternal asthma and retained outcomes with sufficient numbers to support analyses by race/ethnicity [5, 14]. Obstetric outcomes examined included gestational diabetes, gestational hypertension, preeclampsia, maternal hemorrhage, placental abruption, premature rupture of membranes (PROM) and preterm premature rupture of membranes (PPROM < 37 gestational weeks), and preterm delivery (<37 weeks). Neonatal outcomes examined included neonatal intensive care unit (NICU) admission, apnea, respiratory distress syndrome, transient tachypnea of the newborn, anemia, small for gestational age (SGA), and hyperbilirubinemia. SGA was defined as the lowest 10% of birth weight for age and sex of the distribution of birth weight in our population [15].

Statistical Analyses

Descriptive statistics were calculated to summarize the demographic and clinical characteristics of women by race/ethnicity. We examined differences in the distribution of categorical demographic and clinical factors, including maternal asthma across race/ethnicity groups using chi-square tests. The difference in mean maternal age across groups was examined using a Kruskal-Wallis test. We also calculated the prevalence of obstetric and neonatal complications among women with and without asthma across race/ethnicity groups. While we present the prevalence of obstetric and neonatal complications for all groups, sample size limitations did not allow us to examine the interaction between asthma and race/ethnicity for Asian/Pacific Islander women.

We examined the main effects of maternal race/ethnicity together with asthma status on the odds of obstetric and neonatal complications. Adjusted odds ratios (aOR) and their 95% confidence intervals (95% CIs) were estimated with multi-level logistic regression using generalized estimating equations (GEE) and a first-order autoregressive covariance structure, adjusting for demographic and clinical variables. This allowed us to account for correlation among women who contributed more than one pregnancy throughout the study period. We tested for interaction between maternal race/ethnicity and asthma status and

considered a p-value of <0.05 as statistically significant. To ease interpretation and allow for comparison across groups, odds ratios for a given complication for racial/ethnic groups were derived from the same logistic regression model. To account for the varying prevalence of maternal asthma rates and obstetric and neonatal complications across groups, we chose to use women of the same racial/ethnic group without asthma as the reference group for comparisons. Except where noted, odds ratios were adjusted for covariates available in the electronic medical record selected *a priori* based on our previous studies of obstetric and neonatal complications among women with asthma [5,14]. These covariates included maternal age (continuous), marital status (not married/married/missing), insurance (private/public/other/missing), pre-pregnancy body mass index in kg/m^2 (under: <18.5, normal: 18.5 to <25, overweight: 25 to <30, obese: 30 to <35, severely obese: ≥35), smoking (yes/no) and alcohol use (yes/no) during pregnancy, history of chronic disease (pre-pregnancy diabetes, chronic hypertension, thyroid disease, or human immunodeficiency virus), parity (nulliparous/multiparous), cesarean delivery (yes/no), and clinical site.

We excluded women with pre-existing chronic disease from specific analyses when appropriate. In the model for gestational diabetes, we excluded women with (n=362, 2.3%) and without asthma (n=2,695, 1.4%) with a pre-pregnancy diabetes diagnosis. Similarly, women with a prior diagnosis of hypertension were excluded from models for gestational hypertension. This included 479 (3%) and 3,665 (1.8%) women with and without asthma, respectively. Birthweight was missing or implausible for 2,393 patients, including 130 (0.8%) and 2,263 (1.2%) mothers with and without asthma, respectively. We excluded these deliveries from the analyses for SGA and used infants that were appropriate for gestational age (AGA) as the reference category. Information on infant apnea was not recorded at one clinical site and we therefore excluded this site in analyses for this outcome (n = 19,708, 9.4%). We also conducted supplemental analyses using similar methods to compare the outcomes of non-White mothers using White mothers (with and without asthma) as the reference group. All statistical analyses were performed using SAS (version 9.3; SAS, Cary, NC).

Results

Overall, 7.7% of pregnancies were complicated by maternal asthma (n=16,099). Asthma prevalence differed significantly across racial/ethnic groups (p<.0001). Black women had the highest prevalence of asthma (10.8%) followed by Whites (7.4%), Hispanics (5.9%) and Asian/Pacific Islanders (2.3%) (Table 1). Black women appeared to be younger, more frequently unmarried and experienced more prior chronic disease during pregnancy compared with other racial/ethnic groups.

As anticipated, obstetric and neonatal complications were generally more frequent among pregnancies complicated by maternal asthma across all race/ethnicities (Table 2). Except for maternal hemorrhage, the prevalence of complications was found to be statistically different across categories of race/ethnicity (main effect of race p<0.05). Gestational diabetes was more prevalent among Hispanic and Asian/Pacific Islanders, while these groups have lower rates of gestational hypertension. Preterm birth was more prevalent among Black and

Hispanic mothers and many neonatal complications were higher among Black infants. In contrast, hyperbilirubinemia was higher in White and Asian/Pacific Islander infants.

Significant interactions between maternal asthma and race/ethnicity ($p<0.05$) were only observed for two of the eight obstetric complications examined (Table 2): preeclampsia and maternal hemorrhage. White women with asthma were more likely to experience preeclampsia (aOR 1.28; 95% CI 1.15–1.43) and maternal hemorrhage (aOR 1.14; 1.04–1.23) when compared to their non-asthmatic counterparts (Table 3). Obstetric complications among Black women did not differ by asthma status. Using White mothers as the reference group (Supplemental Table 1), risks for non-White women with asthma were generally similar to White women and attenuated compared to the findings for non-asthmatics.

Significant interactions between maternal asthma and race/ethnicity were found for three of the seven neonatal outcomes examined (Table 2): NICU admission, apnea and SGA. Newborns of White and Hispanic mothers with asthma were found to be at an increased odds of NICU admission (aOR 1.19; 1.11–1.28; 1.16; 1.02–1.32, respectively) and SGA (aOR 1.11; 1.02–1.20; 1.26; 1.10–1.44, respectively) (Table 3). Additionally, newborns of Hispanic women with asthma were more likely to experience apnea (aOR 1.32; 1.02–1.69). Black women with asthma were not observed to be at increased odds of neonatal complications when compared to their non-asthmatic counterparts. When the infants of White mothers with asthma were used as the comparison group (Supplemental Table 1), we observed the anticipated pattern of risk among non-asthmatics. Among the infants of asthmatics, we observed fewer differences by race/ethnicity. Black infants were less likely to have apnea and hyperbilirubinemia, but more likely to have anemia and term low birth weight. Both Black and Asian/Pacific Islander infants of asthmatic mothers were less likely to have a term birth weight >4000 grams. Hyperbilirubinema was lower among Asian/Pacific Islander infants. Similar to our findings with obstetric complications, risk estimates among asthmatics were generally attenuated compared to non-asthmatics.

Discussion

In this large retrospective cohort study of US deliveries, we found that maternal asthma does not appear to impact the risk of most obstetric and neonatal complications within racial/ethnic groups. However, a few notable risks for White and Hispanic women were observed. Compared to their non-asthmatic counterparts, White women with asthma were found to be at increased odds of preeclampsia and maternal hemorrhage. NICU admission and SGA were more frequent among newborns born to White and Hispanic mothers. Furthermore, the odds of apnea were greater among newborns born to Hispanic mothers with asthma compared to non-asthmatics. However, we did not find statistical interaction between maternal/race ethnicity and asthma status for six of the eight obstetric and four of the seven neonatal complications examined. Also, despite the high prevalence of maternal asthma as well as obstetric and neonatal complications among Black women and their offspring, we did not observe an increased risk of complications among Black women or their newborns associated with asthma. This is very reassuring and also indicates that maternal asthma may do little to explain the between group disparities in obstetric and neonatal outcomes among racial/ethnic groups.

While Black women have higher rates of asthma and experience higher rates of obstetric and neonatal complications compared to Whites, we did not see a significant change in adverse outcome risk among Black women with asthma compared to Black women without asthma [6, 16–22]. Previous findings have indicated that Black women experience high rates of psychosocial risks such as depression, stress, racial discrimination and racism during pregnancy [22–29]. Reassuringly, our findings suggest that the high rate of maternal asthma among Black women is not significantly contributing to their adverse outcome risk. Given their known risks, Black women with asthma may be more frequently or closely monitored during prenatal care or perhaps given the large number of competing risks among Black women, having asthma does not further impact their risk of complications.

Our findings suggest that maternal asthma may not be a significant contributor to the racial/ethnic disparities in obstetric and neonatal complications in the US. A meta-analysis summarizing the evidence for factors contributing to racial/ethnic disparities in obstetric outcomes grouped factors into five domains which included biology, social circumstances, environmental exposures, behavioral patterns and medical care [30]. The large number of competing risks may explain why maternal asthma does not seem to differentially impact the risk of obstetric and neonatal complications across racial ethnic groups, especially among Black women. Our clinical data does not allow for investigation of important social factors such as poverty in our analyses.

The relationship between maternal asthma and obstetric and neonatal outcomes has been widely studied, but differences across race/ethnicity have not been examined [3, 5, 14, 31–39]. To the best of our knowledge, our study is the first to investigate the joint effects of maternal asthma by maternal race/ethnicity on the odds of obstetric and neonatal complications. One prior study that investigated health disparities in maternal asthma used White women as the comparison group instead of assessing the within group difference between racial/ethnic groups [12]. We also observed that asthma prevalence is found to vary widely across racial/ethnic groups and we decided to explore the impact maternal asthma had on the within-group risk of obstetric and neonatal complications examined.

In general, compared to data on asthmatic women from the National Inpatient Sample (NIS), we observed higher prevalence for some obstetric complications including gestational diabetes (Asian/Pacific Islanders 11.3 vs 7.2%), preeclampsia (Whites 5.3 vs 1.6%), PROM (Hispanic 8.2 vs 2.9%) and postpartum hemorrhage (Whites 8.7 vs 2.7%) [12]. The increased rates may be due to differences in the study design and population. The NIS collects data from the Healthcare Cost and Utilization Project (HCUP) and only included discharge data, as opposed to our study that had access to both EMRs and discharge data. This may have allowed us to better capture the outcomes examined. Additionally, temporal changes in recordkeeping or diagnostics could have influenced these differences. The NIS study was conducted between 1998–1999 and the CSL was conducted from 2002 to 2008.

There were several limitations to our study that should be considered. We did not have a sufficient sample of Asian Americans to evaluate the differential impact of asthma on the outcomes examined, although our supplemental analysis compares their outcomes to Whites. A study in California found differences in obstetric outcomes exist between Asian

groups with Cambodians/Laotians having the highest risk profiles compared to Japanese [40]. Maternal asthma has also been shown to vary across Hispanic subgroups. Previous studies support the finding that Puerto Rican women have higher rates of severe asthma compared to other Hispanic women and it is important to examine whether this severity impacts neonatal outcomes differentially within Hispanic subgroups [1]. The CSL did not capture information on subgroups of Hispanic ethnicity. Our data are nationwide and few restrictions for cohort entry were imposed (gestational age ≥23 weeks, for example) with no restrictions for race, asthma or complications, although centers were located primarily in urban areas. We assume our data are fairly representative of the experience in contemporary labor and delivery practice in urban centers.

Similarly, because our study relied on delivery admission EMRs and ICD-9 codes, there was no specific information regarding asthma severity, symptoms and medication use. Previous studies have found that women with poor asthma control are more likely to experience adverse pregnancy outcomes [4, 41]. We were unable to evaluate the joint effects of maternal asthma and race/ethnicity among subgroups of women with varying levels of asthma control. However, under the assumption that they were more likely to have asthma complicating pregnancy, we conducted sensitivity analyses restricting our population to women with asthma in their discharge summary. In addition, we excluded sites with the two highest and two lowest asthma prevalence in our prior studies [5, 14]. Neither scenario was found to impact our findings giving some confidence that our findings are not due to bias in reporting by site or complication. Covariate data such as alcohol use and smoking from the EMR are also likely to be primarily based on self-report and the prevalence could be underestimated.

Despite these limitations, the availability of detailed clinical information in our study has helped to provide a better understanding of the complications experienced by women with asthma in a racially diverse contemporary US cohort. For the various outcomes examined, some data were only available from the EMR, identified via hospital discharge codes, or when possible we combined hospital discharge data with data from EMRs. While hospital discharge data and EMRs have been found to be accurate sources of pregnancy related outcomes, using an additional source to identify outcomes has proven to increase ascertainment [42].

While non-White racial/ethnic groups are often more likely to experience obstetric and neonatal complications compared to White women, our findings suggest this is not the case among women with asthma. Between-group comparisons demonstrated that non-Hispanic White women with asthma and their infants had outcomes that were more similar to their White counterparts than those without asthma. In addition, we observed that maternal asthma did not increase the risk for most of the obstetric and neonatal complications examined within non-White racial/ethnic groups.

In conclusion, the results of our study suggest that maternal asthma does not differentially impact the prevalence of most of the obstetric and neonatal complications examined across racial/ethnic groups. However, given the increased risks observed for White and Hispanic women with asthma, particular attention should be given to these women during prenatal

care to ensure that their asthma is being managed and controlled to reduce the likelihood of obstetric and neonatal complications. Despite the high prevalence of asthma and increased risks for complications among Black women, asthma status did not confer additional risks to Black women and their infants. Future studies can examine whether asthma does not confer additional risks to Black women due to underreporting of complications, competing risks, or greater care to control asthma among Black women given their high risk status. We also encourage additional study of Asian/Pacific Islander women, a widely understudied population in obstetric and neonatal health which we did not have power to fully evaluate in these analyses. Future work is needed to confirm our findings, especially given the insufficient knowledge on racial/ethnic differences in obstetric and neonatal among asthmatic women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

The authors thank the institutions involved in the Consortium on Safe Labor include, in alphabetical order, Baystate Medical Center, Springfield, Mass; Cedars-Sinai Medical Center Burnes Allen Research Center, Los Angeles, Calif; Christiana Care Health System, Newark, Del; Georgetown University Hospital, MedStar Health, Washington, DC; Indiana University Clarian Health, Indianapolis, Ind; Intermountain Healthcare and the University of Utah, Salt Lake City, Utah; Maimonides Medical Center, Brooklyn, NY; MetroHealth Medical Center, Cleveland, Ohio; Summa Health System, Akron City Hospital, Akron, Ohio; The EMMES Corporation, Rockville Md (Data Coordinating Center); University of Illinois at Chicago, Chicago, Ill; University of Miami, Miami, Fla; and University of Texas Health Science Center at Houston, Houston, Texas.

Funding

This research was supported by the Intramural Research Program of the National Institutes of Health (NIH), *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD). The data included in this paper were obtained from the Consortium on Safe Labor, supported by the Intramural Research Program of the NIH, NICHD, through contract number HHSN267200603425C.

Abbreviations

95% CIs	95% Confidence intervals
aORs	Adjusted odds ratios
ACOG	American College of Obstetrics and Gynecology
AGA	Appropriate for gestational age
CSL	Consortium on Safe Labor
EMRs	Electronic medical records
GEEs	Generalized estimating equations
HCUP	Healthcare Cost and Utilization Project
ICD-9	International Classification of Diseases, 9th edition
NIS	National Inpatient Sample

NICU	Neonatal intensive care unit
PROM	premature rupture of membranes
PPROM	preterm premature rupture of membranes
SGA	small for gestational age

References

1. Kwon HL, Triche EW, Belanger K, Bracken MB. The epidemiology of asthma during pregnancy: Prevalence, diagnosis, and symptoms. Immunol Allergy Clin North Am. 2006; 26(1):29–62. [PubMed: 16443142]
2. Kwon HL, Belanger K, Bracken MB. Asthma prevalence among pregnant and childbearing-aged women in the united states: Estimates from national health surveys. Annals of Epidemiology. 2003; 13(5):317–324. [PubMed: 12821270]
3. Murphy VE, Namazy JA, Powell H, Schatz M, Chambers C, Attia J, Gibson PG. A meta-analysis of adverse perinatal outcomes in women with asthma. Bjog-Int J Obstet Gy. 2011; 118(11):1314–1323.
4. Enriquez R, Griffin MR, Carroll KN, Wu PS, Cooper WO, Gebretsadik T, Dupont WD, Mitchel EF, Hartert TV. Effect of maternal asthma and asthma control on pregnancy and perinatal outcomes. J Allergy Clin Immun. 2007; 120(3):625–630. [PubMed: 17658591]
5. Mendola P, Laughon SK, Mannisto TI, Leishear K, Reddy UM, Chen Z, Zhang J. Obstetric complications among us women with asthma. American Journal of Obstetrics and Gynecology. 2013; 208(2)
6. [accessed January 14, 2014] Trends in asthma prevalence, health care use, and mortality in the united states, 2001–2010. 2012. http://www.cdc.gov/nchs/data/databriefs/db94.htm
7. Bryant AS, Washington S, Kuppermann M, Cheng YW, Caughey AB. Quality and equality in obstetric care: Racial and ethnic differences in caesarean section delivery rates. Paediatr Perinat Ep. 2009; 23(5):454–462.
8. MacDorman MF, Munson ML, Kirmeyer S. Fetal and perinatal mortality, united states, 2004. Natl Vital Stat Rep. 2007; 56(3):1–19. [PubMed: 17983023]
9. Alexander GR, Wingate MS, Bader D, Kogan MD. The increasing racial disparity in infant mortality rates: Composition and contributors to recent us trends. Am J Obstet Gynecol. 2008; 198(1):51 e1–51 e9. [PubMed: 17870043]
10. Matthews TJ, MacDorman MF. Infant mortality statistics from the 2010 period linked birth/infant death data set. Natl Vital Stat Rep. 2013; 62(8):1–26.
11. Creanga AA, Bateman BT, Kuklina EV, Callaghan WM. Racial and ethnic disparities in severe maternal morbidity: A multistate analysis, 2008–2010. Am J Obstet Gynecol. 2014; 210(5):435 e1–435 e8. [PubMed: 24295922]
12. MacMullen NJ, Tymkow C, Shen JJ. Adverse maternal outcomes in women with asthma: Differences by race. MCN Am J Matern Child Nurs. 2006; 31(4):263–268. [PubMed: 16940824]
13. Zhang J, Troendle J, Reddy UM, Laughon SK, Branch DW, Burkman R, et al. Contemporary cesarean delivery practice in the united states. Am J Obstet Gynecol. 2010; 203(4):326 e1–326 e10. [PubMed: 20708166]
14. Mendola P, Mannisto TI, Leishear K, Reddy UM, Chen Z, Laughon SK. Neonatal health of infants born to mothers with asthma. J Allergy Clin Immun. 2014; 133(1):85. [PubMed: 23916153]
15. Männistö T, Mendola P, Reddy U, Laughon SK. Neonatal outcomes and birth weight in pregnancies complicated by maternal thyroid disease. Am J Epidemiol. 2013; 178(5):731–740. [PubMed: 23666815]
16. Geronimus AT. Black/white differences in the relationship of maternal age to birthweight: A population-based test of the weathering hypothesis. Soc Sci Med. 1996; 42(4):589–597. [PubMed: 8643983]

17. Polednak AP. Black-white differences in infant-mortality in 38 standard metropolitan statistical areas. Am J Public Health. 1991; 81(11):1480–1482. [PubMed: 1951808]
18. Rossen LM, Schoendorf KC. Trends in racial and ethnic disparities in infant mortality rates in the united states, 1989–2006. Am J Public Health. 2014; 104(8):1549–1556. [PubMed: 24028239]
19. Cabacungan ET, Ngui EM, McGinley EL. Racial/ethnic disparities in maternal morbidities: A statewide study of labor and delivery hospitalizations in wisconsin. Matern Child Hlth J. 2012; 16(7):1455–1467.
20. Schaaf JM, Liem SM, Mol BW, Abu-Hanna A, Ravelli AC. Ethnic and racial disparities in the risk of preterm birth: A systematic review and meta-analysis. American journal of perinatology. 2013; 30(6):433–450. [PubMed: 23059494]
21. Ehrenthal DB, Jurkovitz C, Hoffman M, Kroelinger C, Weintraub W. A population study of the contribution of medical comorbidity to the risk of prematurity in blacks. American Journal of Obstetrics and Gynecology. 2007; 197(4)
22. Lu MC, Chen B. Racial and ethnic disparities in preterm birth: The role of stressful life events. American Journal of Obstetrics and Gynecology. 2004; 191(3):691–699. [PubMed: 15467527]
23. Orr ST, Blazer DG, James SA. Racial disparities in elevated prenatal depressive symptoms among black and white women in eastern north carolina. Annals of Epidemiology. 2006; 16(6):463–468. [PubMed: 16257228]
24. Jesse DE, Walcott-McQuigg J, Mariella A, Swanson MS. Risks and protective factors associated with symptoms of depression in low-income african american and caucasian women during pregnancy. J Midwifery Wom Heal. 2005; 50(5):405–410.
25. Hogue CJR, Bremner JD. Stress model for research into preterm delivery among black women. American Journal of Obstetrics and Gynecology. 2005; 192(5):S47–S55. [PubMed: 15891712]
26. Collins JW, David RJ, Handler A, Wall S, Andes S. Very low birthweight in african american infants: The role of maternal exposure to interpersonal racial discrimination. Am J Public Health. 2004; 94(12):2132–2138. [PubMed: 15569965]
27. Rosenberg L, Palmer JR, Wise LA, Horton NJ, Corwin MJ. Perceptions of racial discrimination and the risk of preterm birth. Epidemiology. 2002; 13(6):646–652. [PubMed: 12410005]
28. Coogan PF, Yu J, O'Connor GT, Brown TA, Cozier YC, Palmer JR, Rosenberg L. Experiences of racism and the incidence of adult-onset asthma in the black women's health study. Chest. 2014; 145(3):480–485. [PubMed: 23887828]
29. Phillips GS, Wise LA, Rich-Edwards JW, Stampfer MJ, Rosenberg L. Prepregnancy depressive symptoms and preterm birth in the black women's health study. Annals of Epidemiology. 2010; 20(1):8–15. [PubMed: 20006271]
30. Bryant AS, Worjoloh A, Caughey AB, Washington AE. Racial/ethnic disparities in obstetric outcomes and care: Prevalence and determinants. American Journal of Obstetrics and Gynecology. 2010; 202(4):335–343. [PubMed: 20060513]
31. Liu SL, Wen SW, Demissie K, Marcoux S, Kramer MS. Maternal asthma and pregnancy outcomes: A retrospective cohort study. American Journal of Obstetrics and Gynecology. 2001; 184(2):90–96. [PubMed: 11174486]
32. Wen SW, Demissie K, Liu SL. Adverse outcomes in pregnancies of asthmatic women: Results from a canadian population. Annals of Epidemiology. 2001; 11(1):7–12. [PubMed: 11164114]
33. Perlow JH, Montgomery D, Morgan MA, Towers CV, Porto M. Severity of asthma and perinatal outcome. American Journal of Obstetrics and Gynecology. 1992; 167(4):963–967. [PubMed: 1415433]
34. Wang G, Murphy VE, Namazy J, Powell H, Schatz M, Chambers C, Attia J, Gibson PG. The risk of maternal and placental complications in pregnant women with asthma: A systematic review and meta-analysis. J Matern-Fetal Neo M. 2014; 27(9):934–942.
35. Namazy JA, Schatz M. Pregnancy and asthma: Recent developments. Curr Opin Pulm Med. 2005; 11(1):56–60. [PubMed: 15591889]
36. Alexander S, Dodds L, Armson BA. Perinatal outcomes in women with asthma during pregnancy. Obstet Gynecol. 1998; 92(3):435–440. [PubMed: 9721785]
37. Dombrowski MP. Outcomes of pregnancy in asthmatic women. Immunol Allergy Clin. 2006; 26(1) 81-+.

38. Hayes DK, Feigal DW, Smith RA, Fuddy LJ. Maternal asthma, diabetes, and high blood pressure are associated with low birth weight and increased hospital birth and delivery charges: hawai'i hospital discharge data 2003–2008. Hawaii J Med Public Health. 2014; 73(2):49–57. [PubMed: 24567868]

39. Macmullen NJ, Shen JJ, Tymkow C. Adverse maternal outcomes in women with asthma versus women without asthma. Appl Nurs Res. 2010; 23(1):e9–e13. [PubMed: 20122503]

40. Qin C, Gould JB. The asian birth outcome gap. Paediatr Perinat Epidemiol. 2006; 20(4):279–289. [PubMed: 16879500]

41. Schatz M, Dombrowski MP, Wise R, Momirova V, Landon M, Mabie W, et al. Spirometry is related to perinatal outcomes in pregnant women with asthma. American Journal of Obstetrics and Gynecology. 2006; 194(1):120–126. [PubMed: 16389020]

42. Lain SJ, Hadfield RM, Raynes-Greenow CH, Ford JB, Mealing NM, Algert CS, Roberts CL. Quality of data in perinatal population health databases a systematic review. Med Care. 2012; 50(4):E7–E20. [PubMed: 21617569]

Highlights

- Both asthma and race/ethnicity can increase obstetric and neonatal complications.
- We examined asthma-associated risks within race/ethnic groups.
- White asthmatics had higher risk of preeclampsia and hemorrhage than non-asthmatics.
- NICU admission and SGA risk were higher for White and Hispanic infants of asthmatics.
- Asthmatic Black women had similar outcomes as non-asthmatic Black women.
- Maternal asthma is not a major factor in obstetric/neonatal race/ethnic disparities.

Table 1

Demographic and clinical characteristics for women by race/ethnicity in the Consortium on Safe Labor, (n = 208,899), 2002–2008

Maternal characteristics	White 110,603 (52.9%)	Black 50,284 (24.1%)	Hispanic 38,831 (18.6%)	Asian/PI 9,181 (4.4%)	ap-value
Demographic factors					
Asthma diagnosis, n (%)	8, 156 (7.4)	5,444 (10.8)	2,288 (5.9)	211 (2.3)	<.0001
Maternal age, mean (SD)	28.5 (5.8)	25.7 (6.4)	26.8 (6.3)	30.0 (5.3)	<.0001
Marital status, n (%)					
Not married	22,707 (20.5)	36,959 (73.5)	18,962 (48.8)	1,306 (14.2)	<.0001
Married	86,036 (77.8)	12,005 (23.9)	18,589 (47.9)	7,740 (84.3)	
Missing	1,860 (1.7)	1,320 (2.6)	1,280 (3.3)	135 (1.5)	
Insurance, n (%)					
Private	82,094 (74.2)	17,106 (34.0)	11,425 (29.4)	6,448 (70.2)	<.0001
Public	20,760 (18.8)	26,705 (53.1)	18,801 (48.4)	1,291 (14.1)	
Other	846 (0.8)	909 (1.8)	709 (1.8)	218 (2.4)	
Missing	6,903 (6.2)	5,564 (11.1)	7,896 (20.3)	1,224 (13.3)	
Clinical factors					
Prepregnancy BMI, kg/m^2, n (%)					
Underweight, <18.5	4,492 (4.1)	1,209 (2.4)	1,192 (3.1)	625 (6.8)	<.0001
Normal weight, 18.5–<25	44,781 (40.5)	12,421 (24.7)	14,071 (36.2)	3,519 (38.3)	
Overweight, 25–<30	15,497 (14.0)	7,712 (15.3)	7,606 (19.6)	765 (8.3)	
Obese, 30–<35	6,868 (6.2)	4,418 (8.8)	3,384 (8.7)	281 (3.1)	
Severely obese, ≥35	5,071 (4.6)	4,429 (8.8)	1,966 (5.1)	165 (1.8)	
Unknown	33,894 (30.6)	20,095 (40.0)	10,612 (27.3)	3,826 (41.7)	
Smoking during pregnancy, n (%)	8,433 (7.6)	4,058 (8.1)	1,581 (4.1)	138 (1.5)	<.0001
Alcohol during pregnancy, n (%)	2,445 (2.2)	975 (1.9)	404 (1.0)	65 (0.7)	<.0001
Any chronic disease (diabetes, hypertension, thyroid, HIV), n (%)	6,867 (6.2)	3,952 (7.9)	2,136 (5.5)	418 (4.6)	<.0001
Parity, n (%)	44,300 (40.1)	19,386 (38.6)	14,454 (62.8)	4,502 (49.0)	<.0001
Nulliparous					
Cesarean delivery n (%)	22,923 (25.3)	16,006 (31.8)	11,686 (30.1)	2,694 (29.4)	<.0001

aP values are based on chi-square and Kruskal-Wallis test.

Table 2

Obstetric and neonatal outcomes for singleton deliveries by asthma status among women in the Consortium on Safe Labor by race/ethnicity (n = 208,899), 2002–2008

	White		Black		Hispanic		Asian/PI	
	No asthma n = (102,447)	**Asthma n = (8,156)**	**No asthma n = (44,840)**	**Asthma n = (5,444)**	**No asthma n = (36,543)**	**Asthma n = (2,288)**	**No asthma n = (8,970)**	**Asthma n = (211)**
	n (%)							
Obstetric outcomes								
Gestational diabetes	4,520 (4.5)	460 (5.7)	1,905 (4.3)	249 (4.7)	2,318 (6.5)	139 (6.3)	878 (9.9)	23 (11.3)
Gestational hypertension	3,072 (3.0)	317 (4.0)	1,401 (3.3)	169 (3.3)	733 (2.0)	51 (2.3)	109 (1.2)	4 (1.9)
Preeclampsia[a]	4,178 (4.1)	425 (5.3)	2,802 (6.5)	314 (6.1)	1,617 (4.5)	115 (5.2)	373 (4.2)	10 (4.9)
Maternal hemorrhage[a]	7,487 (7.3)	708 (8.7)	2,555 (5.7)	374 (6.9)	2,159 (5.9)	145 (6.3)	461 (5.1)	6 (2.8)
Placental abruption	1,429 (1.4)	160 (2.0)	977 (2.2)	168 (3.1)	532 (1.5)	32 (1.4)	104 (1.2)	2 (1.0)
Preterm delivery, <37 wk	9,569 (9.3)	1,021 (12.5)	7,458 (16.6)	1,006 (18.5)	4,248 (11.6)	327 (14.3)	743 (8.3)	28 (13.3)
PROM	6,869 (6.7)	530 (6.5)	3,413 (7.6)	394 (7.2)	2,292 (6.3)	188 (8.2)	830 (9.3)	19 (9.0)
PPROM	1,937 (1.9)	222 (2.7)	1,432 (3.2)	182 (3.3)	755 (2.1)	77 (3.4)	166 (1.9)	5 (2.9)
Neonatal outcomes								
NICU admission[a]	10,718 (10.5)	1,130 (13.9)	7,241 (16.2)	968 (17.8)	4,060 (10.5)	325 (14.2)	815 (8.9)	17 (8.1)
Apnea[a]	1,709 (1.9)	189 (2.4)	1,401 (3.2)	155 (2.9)	762 (2.1)	69 (3.3)	105 (1.7)	4 (2.2)
Respiratory distress syndrome	2,882 (2.8)	297 (3.6)	2,051 (4.6)	261 (4.8)	1,080 (3.0)	83 (3.6)	142 (1.6)	6 (2.8)
Transient tachypnea of the newborn	3,135 (3.1)	334 (4.1)	2,265 (5.1)	311 (5.7)	11,167 (3.2)	89 (3.9)	178 (2.0)	5 (2.7)
Anemia	1,286 (1.3)	131 (1.6)	1,435 (3.2)	170 (3.1)	742 (2.0)	54 (2.4)	104 (1.2)	1 (0.95)
Size for gestational age SGA[a]	7,883 (8.8)	735 (10.2)	6,452 (15.7)	859 (17.0)	3,449 (10.6)	279 (13.7)	1,035 (12.6)	15 (7.4)

	White		Black		Hispanic		Asian/PI	
	No asthma n = (102,447)	**Asthma n = (8,156)**	**No asthma n = (44,840)**	**Asthma n = (5,444)**	**No asthma n = (36,543)**	**Asthma n = (2,288)**	**No asthma n = (8,970)**	**Asthma n = (211)**
Hyperbilirubinemia	17,827 (17.4)	1,573 (19.3)	3,955 (8.8)	482 (8.9)	4,440 (12.2)	318 (13.9)	1,853 (20.7)	46 (21.8)

Abbreviations: PI, Pacific Islander; wk, weeks; PROM, premature rupture of membranes; PPROM, preterm premature rupture of membranes; NICU, neonatal intensive care unit; SGA, small for gestational age; LGA, large for gestational age.

[a] $p_{\text{interaction}} \leq 0.05$ in fully adjusted model.

Table 3

Adjusted odds ratios and 95% confidence intervals for obstetric and neonatal outcomes among women with asthma in the Consortium on Safe Labor within race/ethnicity groups (n = 208,899), 2002–2008[a]

	White	Black	Hispanic
	n = (110,603)	**n = (50,284)**	**n = (38,831)**
		aOR (95% CI)	
Obstetric outcomes			
Preeclampsia	**1.28 (1.15, 1.43)**	0.91 (0.80, 1.03)	1.03 (0.85, 1.26)
Maternal hemorrhage	**1.14 (1.04, 1.23)**	1.05 (0.93, 1.18)	1.05 (0.87, 1.26)
Neonatal outcomes			
NICU admission	**1.19 (1.11, 1.28)**	1.02 (0.95, 1.11)	**1.16 (1.02, 1.32)**
Apnea	1.06 (0.91, 1.24)	0.85 (0.71, 1.00)	**1.32 (1.02, 1.69)**
Size for gestational age SGA	**1.11 (1.02, 1.20)**	1.06 (0.98, 1.15)	**1.26 (1.10, 1.44)**

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; NICU, neonatal intensive care unit; SGA, small for gestational age.

Bold font indicates significant values.

[a]Reference group is women without asthma within each racial/ethnic group. Estimates adjusted for asthma status, race/ethnicity, maternal age, marital status, insurance, pre-pregnancy body mass index, smoking and alcohol use during pregnancy, history of chronic pre-existing disease, parity, cesarean delivery, and clinical site.