

Examination of maternal mortality risk factors among pregnant women in the United States: A cross-sectional analysis of BRFSS 2017-2019

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Abstract:

Background: Chronic conditions including hypertension, hypercholesterolemia, and diabetes mellitus can lead to maternal death. The last study to investigate the prevalence of these risk factors among pregnant women was published in 2011; thus, the objective of this study was to update the literature regarding these risk factors and associated behaviors.

Methods: Combining 2017, 2018, and 2019 Behavioral Risk Factor Surveillance System datasets, we estimated the prevalence of chronic comorbidities, and calculated adjusted odds ratios (AOR) between disease and health-related risk factors.

Results: High cholesterol was the most prevalent risk factor—11.2% followed by diabetes at 9.6%. The health-related risk factor most related to comorbidities was physical inactivity (28.9%). Age was significantly associated with all three chronic conditions.

Conclusions: Risk factors for childbirth and maternal mortality were more prevalent among women bearing children later in life, and Black and Hispanic pregnant women were more likely to have risk factors associated with these conditions.

Introduction

Each year in the United States (US) hundreds of women die from pregnancy-related deaths that are largely preventable. Contrary to the trends present in countries outside the US, these numbers are on the rise. Between 1990 and 2013, there was a 44% decrease in global maternal mortality; however, the US saw a 1.7% increase in mortality rising from 10 deaths per 100,000 live births to 17.3.¹ This discrepancy between U.S. and global maternal mortality rates is partially due to changes in US policy and differences in worldwide reporting standards.² Although the US definition of maternal mortality is more inclusive than that of the World Health Organization - death within 1 year of pregnancy compared to within 42 days of pregnancy - the difference in mortality can be partially explained by worsening overall health within the US, widening gaps of health disparities, and increasing maternal age.^{3,4}

Chronic disease rates among women of reproductive age have increased in the United States, with approximately 27% of pregnancies affected by a chronic disease.⁵ Although there are a wide range of factors that can predispose women to maternal mortality, cardiovascular issues tend to be the cause for a large number of reported maternal deaths. In 2018, state-based maternal mortality review committees (MMRCs) from nine states reported that cardiovascular conditions were included in the main causes of 50% of pregnancy-related deaths and CDC data from 2019 supported this as well, showing about 33% of these deaths being due to cardiovascular conditions.⁶

First, as hypertension is the leading risk factor for heart disease and stroke,⁷ it is also a major contributing factor to maternal and fetal morbidity, complicating up to 5% of the estimated 4 million pregnancies in the United States annually.⁸ Next, obesity is considered an identifiable risk factor for cardiovascular disease, predisposing women to pregnancy-related death. In addition to predisposing women to cardiovascular disorders, obesity also puts them at risk for other pregnancy complications such as preeclampsia, gestational diabetes, and metabolic disorders.⁹ Nearly half of women of child-bearing age are either overweight or obese¹⁰—conditions which have long been known to complicate pregnancy and delivery, and are associated with increased morbidity for both the mother and the child,¹¹

Increasing trends in the rates of obesity, hypertension, and coronary artery disease are accompanied and amplified by increasing maternal age.¹ Maternal age has been shifting upward over the past 50 years, with a 2015 study reporting nearly 3% of expecting women being over the age of 40.¹ In combination with the increased prevalence of comorbidities past the age of 30, an estimated 50% of all pregnancy-related mortality occurs after this age.¹² Compared to a 20-year-old woman, the odds are 5 times more likely that a woman in her 30's will die during pregnancy or within a year of giving birth.¹³ Risk factors for maternal mortality include physical health, age, and healthcare disparities in minority and low socioeconomic status groups.¹⁴

Compared to White women, Black women are two to three times more likely to die from pregnancy-related complications— which doubles in risk as they pass the age of 30.¹⁵ Further,

the risk of death from pregnancy-related complications for women who identify as American Indian or Native Alaskan was nearly as high as their Black counterparts.¹⁵ The increased likelihood of pregnancy-related death among minorities is linked to increased prevalence of chronic disease,¹⁶ advanced states of these diseases,¹⁷ lack of access to health care, and the quality of care.¹⁸

In addition to maternal mortality, these same conditions account for an additional 60,000 women requiring emergency surgeries during birth or being diagnosed with a life-threatening condition during their pregnancy.¹⁹ As the rates of mortality and hospitalization are commonly assessed in the US, to our knowledge there have been no recent studies that have assessed the prevalence of maternal mortality risk factors among pregnant women in the US. Therefore, the objective of this study was to use a nationally representative sample of the US population to assess the prevalence of comorbidities related to maternal mortality and assess the socioeconomic and lifestyle factors that predicate these risks.

Methods

A cross-sectional study design was used to analyze a combined dataset consisting of 2017, 2018, and 2019 Behavioral Risk Factor Surveillance System (BRFSS) surveys. BRFSS is a Centers for Disease Control and Prevention operated database publishing self-reported, health behavior, and diagnosis related surveys. Using a complex randomized sampling technique which had been previously validated by BRFSS, surveys were collected from all 50 states plus the District of Columbia, Puerto Rico, and Guam. Informed consent was obtained prior to survey completion. This manuscript was developed in adherence to the recommendations published by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.²⁰ Our study utilized publicly available, de-identified data and therefore the an institutional review board determined this study did not constitute human subjects research.

Participants were included if they answered “Yes” to the question: “To your knowledge, are you now pregnant,” which was asked of all women between 18 and 49 years of age. Respondents that were institutionalized, living in military barracks, males, and non-pregnant females were excluded. Extracted data consisted of socio-demographic variables including race, age, income, marital status, number of children in the household, current healthcare coverage, lifestyle behaviors including physical inactivity (sedentary), current smoking status, and alcohol consumption, and the presence of chronic conditions including hypertension, hypercholesterolemia and diabetes mellitus (including prediabetes and gestational diabetes). Smoking status is a calculated, binary variable in BRFSS distinguishing between individuals who currently smoke and those who are former smokers or non-smokers. Sedentary behavior was coded as a binary variable based on the question, “During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?” Alcohol consumption is a calculated, binary variable in BRFSS reporting affirmative if an adult reported having at least one drink of alcohol within the past 30 days. Healthcare coverage was coded as a binary variable with those answering “Yes” or “No” to the following question: “Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare, or Indian Health Service?” Marital status was extracted from the BRFSS survey item which collected individuals relationship status which included options of “Married,” “Divorced,”

“Widowed,” “Seperated,” “Never married,” and “Member of a non-married couple.” A status of ‘married’ has been shown to be significantly associated with better outcomes compared to other statuses,²¹ thus for statistical parsimony, we coded this as a binary variable. Chronic diseases were coded as binary variables if the individual reporting having been diagnosed with the condition.

We first calculated population estimates of demographic characteristics and prevalence rates of the health-related risk factors. Next, multivariable logistic regression models were constructed to determine associations, via adjusted odds ratios (AOR), between chronic disease (hypertension, hypercholesterolemia, and diabetes) and demographic and health-related risk variables. Next, to assess differences in health-related risk factors by race, we constructed a multinomial logistic regression model and examined associations disparities in healthcare coverage, marital status, education, sedentary behavior, alcohol consumption, and smoking via relative risk ratios (RRR). Sampling weights, provided by BRFSS, were adjusted for the combined datasets. Alpha was set at .05, hypotheses were two-sided, and statistical analyses were performed using Stata 16.1 in December 2020.

Results

Demographics of respondents

Response rates for BRFSS were approximately 50%, with a total number of respondents in the combined datasets being 1,305,720. After excluding men and non-pregnant women, 7,101 women were included in this sample, representing a population estimate of 2,308,485. Of these women, 53.3% were between the age of 18 and 29, 27.7% were between 30 and 34 years of age, and 19.0% were over the age of 35 (Table 1). The race and ethnicity of the sample consisted of 49.2% White women, 13.0% Black women, 7.3% Asian women, and 1.5% American Indian or Native Alaskan women. While 32.8% reported having no children, 29.4% reported having 1 child, and 37.88% reported having 2 or more children. Nearly 59.5% of respondents reported attending some college, 57.5% were married and 13% lacked healthcare coverage.

Prevalence of health-related risk factors for maternal mortality

The most prevalent behavioral risk for comorbidities among pregnant women was physical inactivity (28.9%). Additionally, 13.0% of women said they had consumed alcohol in the past 30 days, and 7% said they had smoked tobacco during this time frame (Table 1).

Table 1. Demographic characteristics of pregnant women included collected in 2017, 2018 & 2019 BRFSS surveys. (Sample (n)= 7101; Estimated population (N)=2,308,485).

	n; N	% (95% CI)
Demographics		
Age Group		
18-24	1,522; 630,408	27.46 (25.58-29.44)
25-29	1,947; 593,203	25.84 (24.1-27.66)
30-34	1,953; 636,541	27.73 (25.98-29.55)
35-39	1,145; 306,146	13.34 (11.95-14.86)
40-44	329; 100,434	4.38 (3.66-5.23)
45-49	155; 28,688	1.25 (0.97-1.61)
Race		
White	4,299; 1,135,357	49.18 (47.28-51.08)
Black	639; 299,513	12.97 (11.67-14.4)
Asian	293; 167,873	7.27 (6.03-8.74)
American Indian/Alaskan Native	194; 33,995	1.47 (1.2-1.8)
Hispanic	1,347; 622,149	26.95 (25.09-28.9)
Other	275; 49,597	2.15 (1.8-2.57)
Number of Children in Household		
No children	2,268; 756,272	32.76 (30.85-34.73)
One child	2,117; 677,802	29.36 (27.53-31.27)
Two children	1,427; 466,790	20.22 (18.58-21.97)
Three or more	1,289; 407,619	17.66 (16.11-19.32)
Education		
Less than High School	630; 355,277	15.43 (13.84-17.17)
Completed High School	1,722; 575,615	25 (23.29-26.8)
Some College	1,873; 664,912	28.88 (26.95-30.89)
Completed College	2,855; 706,418	30.68 (28.97-32.46)
Married (Yes)	4,240; 1,269,875	55.01 (52.94-57.06)
No Health Care Coverage	740; 295,864	12.95 (11.61-14.43)
Health-Related Risk Factors		
Hypertension	295; 100,569	6.49 (5.25-7.99)
High Cholesterol	328; 127,425	11.22 (9.17-13.67)
Diabetes or Prediabetes ^a	671; 220,175	9.60 (8.44-10.91)
Sedentary (Past 30 Days)	1,898; 638,342	28.88 (27.02-30.82)
Drinking Alcohol (Past 30 Days)	840; 289,088	13.02 (11.62-14.57)
Currently Smoking	554; 158,498	7.04 (6.07-8.16)

Sample (n) = 7101; Estimated population size (N) = 2,308,485. ^aIncludes gestational diabetes

The most prevalent chronic condition was hypercholesterolemia (11.2%) followed by diabetes mellitus (9.6%) and hypertension (6.5%).

Associations of socio-demographics and chronic conditions among pregnant women

Age was a consistent risk factor for chronic conditions across hypertension (AOR: 1.60; 95%CI: 1.38-1.85), hypercholesterolemia (AOR: 1.22; 95%CI: 1.00-1.49), and diabetes (AOR: 1.28; 95%CI: 1.13-1.46) among pregnant women (Table 2). Other statistically significant associations were found between hypertension and the number of children currently in the household (AOR: 0.79 95%CI: 0.65-0.96) — showing lower odds of having hypertension with more children and having a college degree (AOR: 0.31; 95%CI: 0.16-0.61). Alternatively, being a current smoker increased the odds of having hypertension (AOR: 2.35; 95%CI: 1.39-3.98). Significant factors associated with a diabetes diagnosis among pregnant women were having healthcare coverage (AOR: 1.84; 95%CI: 1.17-2.89), drinking alcohol within the past 30 days (AOR: 1.62; 95%CI: 1.02-2.60), and being Asian American (compared to White women, (AOR: 2.32; 95%CI: 1.21-4.45).

Using White women as the reference model, our final analysis showed that Black women were less likely to be married (RRR: 0.22; 95%CI: 0.16-0.31), more likely to have a high school diploma as their highest level of education (RRR: 1.87, 95%CI: 1.47-2.65), more likely to be sedentary (RRR: 1.97; 95%CI: 1.47-5.65), and less likely to smoke (RRR: 0.31; 95%CI: 0.19-0.53). Asian American women were more likely to have been sedentary (RRR: 1.65; 95%CI: 1.05-2.61) and have consumed alcohol (RRR: 2.03; 95%CI: 1.25-3.31) in the past 30 days, and were less likely to have smoked (RRR: 0.32, 95%CI: 0.13-0.78). Indigenous Americans were more likely to have healthcare coverage (RRR: 9.08; 95%CI: 3.43-24.02) and to have consumed alcohol (RRR: 2.98; 95%CI: 1.86-4.80) while being less sedentary (RRR: 0.55; 95%CI: 0.31-0.96) and less likely to have completed high school. Hispanic women were less likely to have healthcare coverage (RRR: 0.59; 95%CI 0.42-0.84), be married (RRR 0.43; 95%CI: 0.33-0.55), have completed high school, attended college, or have a college degree, and were less likely to smoke (RRR: 0.18; 95%CI: 0.08-0.43). Respondents identifying as ‘other’ were less likely to be married (RRR: 0.55; 95%CI: 0.36-0.84).

Table 2. Associations between presence of chronic conditions and demographic and health-related risk factors among pregnant women

Risk-Related Comorbidities:	Hypertension	High Cholesterol	Diabetes ^a
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age	1.6 (1.38-1.85)	1.22 (1.00-1.49)	1.28 (1.13-1.46)
Race			
White	1 [Reference]	1 [Reference]	1 [Reference]
Black	1.47 (0.89-2.41)	0.95 (0.39-2.33)	1.29 (0.72-2.33)
Asian	0.43 (0.14-1.29)	1.03 (0.45-2.36)	2.32 (1.21-4.45)
American Indian/Alaskan Native	1.54 (0.55-4.37)	0.47 (0.13-1.68)	1.52 (0.61-3.80)
Hispanic	0.84 (0.52-1.37)	0.85 (0.40-1.8)	1.26 (0.79-2.00)
Other	1.81 (0.75-4.37)	0.44 (0.13-1.45)	0.88 (0.42-1.84)
No. of children in HH	0.79 (0.65-0.96)	0.87 (0.72-1.06)	1.08 (0.94-1.25)
Education			
Less than High School	1 [Reference]	1 [Reference]	1 [Reference]
Completed High School	0.58 (0.32-1.05)	0.82 (0.35-1.92)	0.75 (0.46-1.22)
Some College	0.76 (0.44-1.31)	1.11 (0.41-3.02)	0.84 (0.48-1.47)
Completed College	0.31 (0.16-0.61)	0.77 (0.3-1.98)	0.59 (0.33-1.08)
Married			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.88 (0.58-1.36)	1.33 (0.77-2.29)	1.16 (0.8-1.69)
Healthcare Coverage			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	0.91 (0.56-1.46)	0.87 (0.43-1.77)	1.84 (1.17-2.89)
Sedentary			
No			
Yes	0.98 (0.67-1.43)	1.26 (0.73-2.2)	0.81 (0.59-1.11)
Drinking Alcohol (Past 30 Days)			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	1.08 (0.6-1.92)	1.97 (1.15-3.35)	1.62 (1.02-2.6)
Smokes			
No	1 [Reference]	1 [Reference]	1 [Reference]
Yes	2.35 (1.39-3.98)	2.54 (0.84-7.67)	1.53 (0.75-3.14)

AOR = Adjusted Odds Ratio; BMI = Body Mass Index; ^aIncludes gestational diabetes. Bolded text indicates statistical significance.

Discussion

Our study adds to the complexity of identifying characteristics and risk factors for maternal mortality. For instance, we found that having existing children in the household was correlated with a lower incidence of hypertension and that having healthcare or being Asian American increased the likelihood of having a diabetes diagnosis—while Asian American women are generally perceived to be healthier than other races, previous research has shown they may be prone to gestational diabetes due to differences in glucose metabolism and insulin response.^{22,23} Other studies in this area, focusing on individual conditions like diabetes or lifestyle behaviors²⁴⁻²⁷, produced results in line with ours regarding smoking, alcohol, physical activity, and education; however, few have looked at lifestyle behaviors as a link between chronic disease among pregnant women—especially among a nationally representative dataset.

A common risk factor—age—was associated with being diagnosed with each of the chronic diseases we examined. For several decades, maternal age has been shifting upwards as more women choose to postpone their first pregnancy.²⁸ Despite making up a smaller percentage of pregnancies, previous research has shown that pregnant women aged 35 or above account for approximately 30% of pregnancy-related deaths.^{12,13} With the continued advances in the field of reproductive medicine, it is very likely that maternal age will continue to increase. Pregnancies complicated by advanced maternal age require more frequent prenatal visits and neonatal screening to predict or help prevent maternal morbidity and mortality. With the knowledge that the majority of maternal deaths are linked to cardiovascular disorders related to preventable chronic conditions, it is important to observe this group closely and identify opportunities throughout the course of prenatal care to improve their maternal outcomes.

Further, our results also showed that more than one in 10 pregnant women lacked healthcare coverage and that race was linked to a number of underlying risk behaviors—in line with other research.^{7,8,11,23} The convergence of socioeconomic and lifestyle factors' impact on maternal mortality is shown in our examination of racial disparities. Black women were less likely to be married and have attended higher education. A similar trend was also found among Hispanic women in addition to having a lower prevalence of healthcare coverage. These factors likely demonstrate greater financial stress during pregnancy. Additionally, Black and Asian American women were less likely to report exercising in the past 30 days—a known risk factor for cardiovascular disease.^{29,30,31} Indigenous women completed lower levels of education compared to White women but were more likely to have healthcare coverage, likely due to tribally affiliated healthcare.

Table 3. Analysis of racial disparities among factors related to chronic disease and poor maternal outcomes using multinomial logistic regression.

	Black	Asian	AI/AN	Hispanic	Other
Education	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)	RRR (95% CI)
Less than High School	1[Ref]	1[Ref]	1[Ref]	1[Ref]	1[Ref]
Completed High School	1.43 (0.8-2.57)	0.2 (0.11-0.36)	0.44 (3.13-0.2)	0.3 (0.2-0.45)	0.69 (0.31-1.56)
Some College	0.76 (0.41-1.41)	0.13 (0.06-0.27)	0.89 (5.59-0.13)	0.15 (0.1-0.23)	0.79 (0.35-1.8)
Completed College	0.22 (0.16-0.31)	0.19 (0.12-0.3)	0.56 (1.35-0.19)	0.43 (0.33-0.55)	0.55 (0.36-0.84)
Married (Yes)	1.3 (0.76-2.21)	9.08 (3.43-24.02)	0.35 (1.2-9.08)	0.59 (0.42-0.84)	1.26 (0.67-2.39)
No Health Care Coverage	1.97 (1.47-2.65)	0.55 (0.31-0.96)	1.05 (2.61-0.55)	1.27 (0.97-1.67)	1.38 (0.88-2.18)
Sedentary (Past 30 Days)	0.86 (0.55-1.35)	2.98 (1.86-4.8)	1.25 (3.32-2.98)	0.86 (0.54-1.37)	1.8 (1.09-2.97)
Drinking Alcohol (Past 30 Days)	0.31 (0.19-0.53)	0.79 (0.36-1.75)	0.13 (0.78-0.79)	0.18 (0.08-0.43)	1.38 (0.78-2.43)
Currently Smoking	0.31 (0.15-0.66)	0.03 (0.01-0.07)	0.04 (0.29-0.03)	4.24 (2.8-6.43)	0.04 (0.02-0.1)

RRR= Relative risk ratio comparing Race/Ethnicity group to White women.

To generate preventive interventions, it is necessary to develop a clear understanding of the underlying mechanisms that create these health disparities. The connection between income and access to care has been identified,³² yet remains an important consideration for improving maternal mortality rates. For instance, one important clinical aspect to decrease maternal morbidity is to address the lack of care in the immediate postpartum period through the appropriate transition of care after birth, especially in women with hypertension, metabolic syndrome, and other cardiovascular disorders.

To improve maternal mortality rates, it is imperative that efforts extend beyond clinical care delivery strategies to also embrace solutions that address the systemic issues which influence care delivery. By addressing systemic issues in education and healthcare, it may be possible to decrease the prevalence of chronic diseases¹⁹ that are risk factors for pregnancy complications. The nature of healthcare in the US makes it difficult to implement nationwide standardized maternity guidelines; thus, the best opportunity to affect change may be at the state or community level¹⁹ since states can contribute to improvements in maternal health. Policy recommendations at the state and local level can be customized to leverage data and resources to address systemic issues that impact maternal care delivery and outcomes.

This study had several strengths and limitations. Limitations of this study included a moderate response rate among BRFSS surveys. Additionally, the study questionnaire was self-reported, and therefore, response bias may have negatively affected our results. Furthermore, diabetes mellitus type 1 and 2 were not differentiated by BRFSS which may have skewed our results regarding this diagnosis. Finally, this was a cross-sectional analysis; thus, causation statements cannot be made. Study strengths included the large sample size and robust sampling procedures.

Conclusion

This study identified key characteristics and risk factors for maternal mortality in the US demonstrating that a closer examination of these disparities may be useful in making necessary changes in local, state, and national level public health initiatives. Increasing maternal age is a known risk factor for hypertension, hypercholesterolemia and diabetes among pregnant women; addressing lifestyle behaviors, socio-economic issues, and racial disparities linked to these chronic diseases may reduce the risk of severe complications and deaths during pregnancy and childbirth.

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