## OBSTETRICS

# Maternal age and risk for adverse outcomes

Check for updates

Jean-Ju Sheen, MD; Jason D. Wright, MD; Dena Goffman, MD; Adina R. Kern-Goldberger, MD; Whitney Booker, MD;
Zainab Siddiq, MS; Mary E. D'Alton, MD; Alexander M. Friedman, MD, MPH

**OBJECTIVE:** The objective of this study was to characterize the risk for severe maternal morbidity and other pregnancy complications by maternal age during delivery hospitalizations.

**STUDY DESIGN:** This retrospective cohort analysis used the Perspective database to characterize the risk for adverse maternal outcomes from 2006 to 2015 based on maternal age. Women were divided into 7 categories based on maternal age: 15—17, 18—24, 25—29, 30—34, 35—39, 40—44, and 45—54 years of age. The primary outcome of this study was severe maternal morbidity as defined by the Centers for Disease Control and Prevention. Secondary outcomes included (1) overall comorbid risk; (2) risk for pregnancy complications such as postpartum hemorrhage, gestational diabetes, preeclampsia, and cesarean delivery; and (3) risk for individual severe morbidity diagnoses such as stroke, embolism, eclampsia, and hysterectomy. Adjusted models were fitted to assess factors associated with severe morbidity with adjusted risk ratios (aRRs) and 95% confidence intervals (CI) as measures of effect. Population weights were applied to create national estimates.

**RESULTS:** Of 36,944,292 deliveries included, 2.5% occurred among women aged 15—17 years (n = 921,236), 29.1% to women aged 18—24 years (n = 10,732,715), 28.6% to women aged 25—29 years (n = 10,564,850), 24.9% to women aged 30—34 years (n = 9,213,227),

12.1% to women aged 35—39 years (n = 4,479,236), 2.6% to women aged 40—44 years (n = 974,289), and 0.2% to women aged 45—54 years (n = 58,739). In unadjusted analyses, severe morbidity was more than 3 times higher (risk ratio [RR], 3.33, 95% confidence interval [CI], 3.03—3.66) for women 45-54 years compared with women 25—29 years. Women aged 40—44, 35—39, and 15—17 years were also at increased risk (RR, 1.83, 95% CI, 1.77—1.89; RR, 1.36, 95% CI, 1.33—1.39; RR, 1.39, 95% CI, 1.34—1.45, respectively). In the adjusted model, the 45—54 year old group was associated with the highest relative risk (aRR, 3.46, 95% CI, 3.15—3.80) followed by the 40—44 year old group (aRR 1.90, 95% CI, 1.84—1.97), the 35—39 year old group (aRR, 1.43, 95% CI, 1.40—1.47), and the 15—17 year old group (aRR, 1.20, 95% CI, 1.15—1.24). Cesarean delivery, preeclampsia, postpartum hemorrhage, and gestational diabetes were most common among women aged 45—54 years, as were thrombosis and hysterectomy.

**CONCLUSION:** While differential risk was noted across maternal age categories, women aged 45 years old and older were at highest risk for a broad range of adverse outcomes during delivery hospitalizations.

**Key words:** very advanced maternal age, severe morbidity, maternal risk

W hile the overall birth rate in the United States has declined over the past decade, births to women aged 30 years old and older have risen. Socioeconomic trends and advances in assisted reproductive technology have resulted in women having children at later ages. From 2007 to 2016, birth rates rose 2% for women in their early 30s, 11% for women in their late 30s, and 19% for women in their early 40s.[1]

In 2016, the birth rate for women 45—49 years old (and including births to women 50 years old and older) was 0.9 per 1000 women, the highest rate for this age group since 1963.[2] The trend of more frequent births among older women, particularly those of very advanced

maternal age (≥45 years of age), is likely to continue as newer reproductive technologies become more widely available.[3]

For older women intending to become pregnant, data on the risk for adverse outcomes may represent an important consideration. While advanced maternal age of ≥35 years of age is generally associated with both adverse maternal and neonatal pregnancy outcomes, there may be important differentials in the risk for women 35—39, 40—45, and older than 45 years. While some risks, such as aneuploidy, may decrease with oocyte donation or be detected through prenatal screening,[4—7] the degree of age-based risk for adverse outcomes in the population of advanced maternal age is unclear, particularly for women aged 45 years and older.

Older women are more likely to have underlying comorbid conditions such as obesity, diabetes, and hypertension; even accounting for preexisting illness, healthy women of advanced maternal age have increased pregnancy
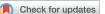
complication rates.[4,8—10] Population-based data on how age relates to adverse maternal outcomes in the setting of comorbidity are limited.

Given that knowledge of population-based risk related to adverse maternal outcomes may be of use to both patients and providers, the objective of this study was to characterize the maternal age-related risk for severe maternal morbidity and pregnancy complications such as cesarean delivery, preeclampsia, gestational diabetes, and postpartum hemorrhage.

## Materials and Methods

The Perspective database was used for this analysis. Perspective is maintained by Premier Incorporated (Charlotte, NC) and includes patient demographics, hospital characteristics, and discharge diagnosis codes as well as medications and devices administered during acute care hospitalizations.

Within Perspective, 100% of hospitalizations for individual hospitals are

<table>
<tr><td>

**TABLE 1**

**Centers for Disease Control and Prevention Severe Maternal Morbidity Indicators**

| Conditions |
| --- |
| Acute myocardial infarction |
| Aneurysm |
| Acute renal failure |
| Adult respiratory distress syndrome |
| Amniotic fluid embolism |
| Cardiac arrest/ventricular fibrillation |
| Conversion of cardiac rhythm |
| Disseminated intravascular coagulation |
| Eclampsia |
| Heart failure/arrest during surgery or procedure |
| Puerperal cerebrovascular disorders |
| Pulmonary edema/acute heart failure |
| Severe anesthesia complications |
| Sepsis |
| Shock |
| Sickle cell disease with crisis |
| Air and thrombotic embolism |
| Blood transfusion |
| Hysterectomy |
| Temporary tracheostomy |
| Ventilation |

Modified from Centers for Disease Control and Prevention: Severe maternal morbidity indicators and corresponding *International Classification of Diseases* codes during delivery hospitalizations. Available at: https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/severe-morbidity-ICD.htm. Accessed July 2, 2018.

*Sheen et al. Maternal age, adverse outcomes, and maternal risk. Am J Obstet Gynecol 2018.*

</td></tr>
</table>

## AJOG at a Glance

### Why was this study conducted?
To evaluate risk for adverse outcomes by maternal age.

### Key findings
While differential risk was noted across maternal age categories, women 45 years old and older were at highest risk for a broad range of adverse outcomes during delivery hospitalizations.

### What does this add to what is known?
Women aged 45 years old and older are at more than 3 times higher risk for severe morbidity when compared with women 25–29 years old.

reported. Ninety-five quality assurance and validation checks are performed on data each year prior to being released.[11] Perspective is routinely used for research on trends during delivery hospitalizations.[12–14] The discharges included in the Perspective database account for approximately 15% of inpatient hospital stays annually in the United States. The Columbia University Institutional Review Board deemed the study exempt, given that all data are deidentified.

Women 15–54 years of age were included in this analysis if they were admitted for a delivery hospitalization between January 2006 and March 2015. Delivery hospitalizations were captured with *International Classification of Diseases*, ninth revision, Clinical Modification (ICD-9-CM) diagnosis codes 650 and V27.x. These criteria ascertain >95% of delivery hospitalizations.[15]

For this analysis women were divided into 7 categories based on maternal age: 15–17, 18–24, 25–29, 30–34, 35–39, 40–44, and 45–54 years of age. We compared demographic and hospital characteristics of women based on maternal age. Demographic characteristics included maternal race (white, black, Hispanic, other), marital status (married, single, unknown), year of delivery (2006–2015), and insurance status (commercial, Medicare, Medicaid, uninsured, and unknown). Hospital characteristics included location (urban vs rural), teaching status (teaching vs nonteaching), geographic region (Midwest, Northeast, South, West), and hospital bed size (small, medium, large).

The primary outcome of this study was severe maternal morbidity, as defined by the Centers for Disease Control and Prevention (CDC).[16] The CDC definition of severe maternal morbidity encompasses 21 diagnoses such as shock, stroke, heart failure, transfusion, and other conditions, all identified using ICD-9-CM codes (Table 1).[17] Additionally, because the most common diagnosis in the severe morbidity composite is transfusion (ICD-9-CM 99.0x) a sensitivity analysis was performed excluding transfusion and was restricted to the remaining 20 conditions representative of non-transfusion severe morbidity.

We evaluated 5 sets of secondary outcomes. First, we evaluated temporal trends by maternal age for the diagnoses of preeclampsia, cesarean delivery, postpartum hemorrhage, and gestational diabetes.

Second, we evaluated the risk for individual severe morbidity conditions including stroke, embolism, eclampsia, and hysterectomy.

Third, we evaluated temporal trends in comorbid risk by maternal age as measured by an obstetric comorbidity index.[18] This comorbidity index provides weighted comorbidity scores for individual patients based on the presence of specific diagnosis codes and demographic factors present in administrative data. Higher scores are associated with an increased risk for severe morbidity. In the initial study validating the comorbidity index, patients with the lowest score of 0 had a 0.68% risk of severe morbidity, whereas a score of >10 was associated with a 10.9% risk of severe morbidity.[18] This comorbidity index was subsequently validated in an external population.[19] Because the comorbidity index includes maternal age, we modified this scoring system excluding maternal age for the present analysis.

Fourth, we determined the degree to which severe morbidity differed by maternal age for women with the same comorbidity index score. Fifth, we evaluated the risk for the following individual severe morbidity outcome diagnoses