

# Impact of Maternal Age on Obstetric Outcome

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**OBJECTIVE:** To estimate the effect of maternal age on obstetric outcomes.

**METHODS:** A prospective database from a multicenter investigation of singletons, the FASTER trial, was studied. Subjects were divided into 3 age groups: 1) less than 35 years, 2) 35–39 years, and 3) 40 years and older. Multivariable logistic regression analysis was used to assess the effect of age on outcomes after adjusting for race, parity, body mass index, education, marital status, smoking, medical history, use of assisted conception, and patient's study site.

**RESULTS:** A total of 36,056 women with complete data were available: 28,398 (79%) less than 35 years of age; 6,294 (17%) 35–39 years; and 1,364 (4%) 40 years and older. Increasing age was significantly associated with miscarriage (adjusted odds ratio [adjOR] 2.0 and 2.4 for ages 35–39 years and age 40 years and older, respectively), chromosomal abnormalities (adjOR 4.0 and 9.9), congenital anomalies (adjOR 1.4 and 1.7), gestational diabetes (adjOR 1.8 and 2.4), placenta previa (adjOR 1.8 and 2.8), and cesarean delivery (adjOR 1.6 and 2.0). Patients aged 35–39 years were at increased risk for macrosomia (adjOR 1.4). Increased risk for abruption (adjOR 2.3), preterm delivery (adjOR 1.4), low birth weight (adjOR 1.6), and perinatal mortality (adjOR 2.2) was noted in women aged 40 years and older.

**CONCLUSION:** Increasing maternal age is independently

associated with specific adverse pregnancy outcomes. Increasing age is a continuum rather than a threshold effect. (*Obstet Gynecol* 2005;105:983–90. © 2005 by The American College of Obstetricians and Gynecologists.)

**LEVEL OF EVIDENCE:** II-2

Advanced maternal age, defined as age 35 years and older at estimated date of delivery, has become increasingly common. From 1970 to 2000, live births among women aged 35 years and older in the United States increased from approximately 5% to approximately 13% of all live births.<sup>1</sup> Effective birth control, advances in assisted reproductive technology (ART), delayed marriage, increasing rates of divorce followed by remarriage, and women's pursuit of higher education and career advancement all contribute to this trend.<sup>2–4</sup>

It is well established that advancing maternal age is associated with subfertility, chromosomal abnormalities, and multiple gestation.<sup>5–7</sup> A large body of literature exists describing the impact of advanced maternal age on maternal and fetal outcomes.<sup>2–31</sup> Unfortunately, the data are conflicting. Although a number of studies found an association between delaying child birth and adverse maternal and fetal outcomes,<sup>2,3,7,11,25,26,30</sup> other studies challenge these findings.<sup>8,18</sup> As the number of advanced-maternal-age gravidas continues to grow, obstetric care providers would benefit from up-to-date outcome data to enhance their preconceptual and antenatal counseling. The purpose of this study is to evaluate obstetric outcomes in advanced-maternal-age women in a large, contemporary, and unselected obstetric population.

## MATERIALS AND METHODS

The First and Second Trimester Evaluation of Risk (FASTER) trial, a National Institute of Child Health and Human Development (NICHD)-sponsored study, is a prospective multicenter investigation of singleton pregnancies from an unselected obstetric population. From

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October 1, 1999, to December 31, 2002, this study evaluated first-trimester nuchal translucency along with first- and second-trimester serum markers for the purpose of assessing Down syndrome risk. Fifteen centers throughout the United States participated in this study. The FASTER trial was approved by the institutional review board at each of the 15 participating study sites. A database was created containing detailed antenatal, birth, and pediatric outcome data for all enrolled patients.

Patients who were pregnant and at less than 14 weeks of gestation were recruited into the FASTER trial by advertising at local antenatal clinics and by referral from local obstetric care providers. After written informed consent was obtained, patients were enrolled into the FASTER trial at 10–14 weeks of gestation, at which time baseline data were recorded by questionnaire and patient interview. All subjects had a viable singleton intrauterine pregnancy without evidence of anencephaly or cystic hygroma, which was confirmed by ultrasound examination at the time of trial enrollment. Postdelivery follow-up was performed by telephone interview of the patient or medical record review by the research coordinator at each site. A purpose-designed computerized tracking system with up to 10 contacts per subject was used to ensure complete outcome collection for all enrolled patients. In addition, a single perinatologist and a pediatric geneticist reviewed detailed maternal and pediatric medical records for the following patient subsets: abnormal first- and/or second-trimester screening, adverse obstetric or pediatric outcome, and 10% of normal subjects randomly selected at each site from the trial database. For this investigation, all subjects with complete outcome information were divided into 3 age groups: 1) age less than 35 years, 2) ages 35–39 years, and 3) age 40 years and older at delivery.

We studied the following adverse pregnancy outcomes: threatened abortion (vaginal spotting or bleeding in the 4 weeks before enrollment),<sup>32</sup> miscarriage (fetal loss after enrollment but before 24<sup>0/7</sup> weeks), perinatal mortality (intrauterine death after 23<sup>6/7</sup> weeks completed gestation and neonatal death within 28 days of birth), chromosomal abnormalities, fetal/neonatal congenital abnormalities (intracranial abnormalities, cleft lip, cleft palate, cardiac defects, thoracic abnormalities, renal malformations, gastrointestinal malformations, urogenital malformations, skeletal malformations, and neural tube defects), gestational hypertension (blood pressure > 140/90 on at least 2 occasions greater than 6 hours apart without evidence of chronic hypertension or significant proteinuria), preeclampsia (criteria for gestational hypertension and significant proteinuria), gestational diabetes (nonfasting 50 g oral glucose challenge test  $\geq$  135 followed by 2 or more abnormal values on fasting 100 g

oral glucose tolerance test [fasting  $\geq$ 95, 1-hour  $\geq$  180, 2-hour  $\geq$  155, 3-hour  $\geq$  140]), preterm labor (persistent uterine contractions accompanied by cervical change on digital examination before 37 weeks of gestation), preterm premature rupture of membranes (preterm PROM, membrane rupture before 37 weeks of gestation), preterm delivery (delivery before 37 weeks of gestation), low birth weight (birth weight < 2,500 g), macrosomia (birth weight > 4,500 g), placental abruption (premature separation of a normally implanted placenta), placenta previa (placenta completely or partially covering the internal cervical os at the time of delivery), operative vaginal delivery (forceps- or vacuum-assisted delivery), and cesarean delivery.

Potential confounding factors to the relationship between advancing maternal age and obstetric outcomes included race, parity, body mass index (BMI), level of education, marital status, smoking, history of medical problems, previous adverse pregnancy outcome, history of assisted conception such as ovulation induction or ART (in vitro fertilization–transcervical embryo transfer, gamete and zygote intrafallopian transfer, frozen embryo transfer, or donor embryo transfer), and patient's study site. History of pre-existing medical conditions included pregestational diabetes, cardiac disease, chronic hypertension, renal disease, thyroid disease, autoimmune disease, seizure disorders, neurologic disorders, psychiatric disorders, and genetic abnormalities (maternal or paternal). History of using medications before conception, such as insulin, cardiac medications, antihypertensives, anticoagulants, antiepileptics, antidepressants, antipsychotics, prednisone, thyroid replacement, or antithyroid medications, was also obtained. Previous adverse pregnancy outcomes included patient report of prior miscarriage, preterm delivery, and fetal/neonatal chromosomal or structural abnormality.

Statistical analysis was performed to evaluate the effect of increased maternal age on the specific pregnancy outcomes, considered separately. All analyses were performed with SAS 8.2 (SAS Institute Inc, Cary, NC). Patients less than 35 years of age at estimated date of delivery composed the referent group. First, descriptive statistics of each pregnancy outcome and potential confounding variable were generated, for all patients overall and for each of the 3 groups. Next, a bivariate analysis of maternal age group and each specific outcome was conducted with  $\chi^2$  tests. Potential confounders were initially considered based on statistical significance at the bivariate level with either maternal age or outcomes. Tests included analysis of variance for the continuous confounders and  $\chi^2$  tests for the categorical confounders.



**Table 1.** Patient Characteristics by Maternal Age

	Age < 35 y (n = 28,398)	Age 35–39 y (n = 6,294)	Age ≥ 40 y (n = 1,364)	P
Race				< .001
African American	5.2	4.3	5.7	
Hispanic	24.7	13.6	13.7	
White	65.4	75.8	75.4	
Other	4.6	6.3	5.3	
Prior pregnancy	51.5	67.0	66.9	< .001
Body mass index [mean (SD)]	24.9 (5.3)	25.3 (5.2)	26.0 (5.4)	< .001
Years of education [mean (SD)]	14.1 (2.6)	15.3 (2.1)	15.2 (2.3)	< .001
Married	76.0	88.5	85.0	< .001
Smoker	4.9	3.7	4.8	< .001
Pre-existing medical condition	36.1	43.5	51.5	< .001
Pregestational diabetes	0.9	1.4	1.7	< .001
Chronic hypertension	0.5	1.4	1.6	< .001
Parental history of chromosomal abnormality	1.8	1.8	2.3	.387
History of miscarriage	22.8	37.3	49.8	< .001
History of a fetal/neonatal abnormality	3.2	5.1	7.4	< .001
History of preterm delivery	6.2	8.3	10.6	< .001
Assisted conception in current pregnancy				< .001
Ovulation induction	2.9	4.9	6.9	
ART	0.6	3.4	11.8	

SD, standard deviation; ART, assisted reproductive technology.

Data are presented as percentage of cases, except where otherwise indicated.

The crude and adjusted effects of the older maternal ages on each of the adverse pregnancy outcomes were then estimated by using multivariable logistic regression. Final confounders for the adjusted models were selected during multivariable modeling, based on a backward elimination stepwise regression approach, keeping only those variables that were significant at a level of .05.

The confounders controlled for in the final models included BMI, race, education, marital status, smoking, preexisting medical condition, history of adverse pregnancy outcome, use of assisted reproductive care, and patient's study site. Adjusted odds ratios (adjORs) with 95% confidence intervals (CIs) were determined, and  $P < .05$  was considered statistically significant, indicating that a difference in risk exists between the age groups. However, because of the large sample size, statistical analysis was powerful enough to detect differences in risk between the age groups that were statistically significant but where the actual size of the difference was small. In some cases the differences might be so small that they are not clinically meaningful. Therefore, since the OR describes the magnitude of the effect between groups, an adjOR cutoff of greater than 2.0 was chosen to represent clinically meaningful risk to emphasize those outcomes that have a marked association with maternal age and to strengthen the relevance of the study. Thus,  $P < .05$  and adjOR < 2.0 was considered statistically significant but possibly not meaningful clinically.  $P < .05$  and adjOR > 2.0 was considered both statistically and clinically significant.

## RESULTS

A total of 36,056 records with complete antenatal, birth, and pediatric outcome were available for review. One hundred seventy-one patients who terminated their pregnancies after enrollment in the FASTER Trial were not included in this study of advanced maternal age and pregnancy outcomes because they did not have complete obstetric follow-up.

Patients were subdivided into 3 age groups: 1) 28,398 (79%) aged less than 35 years, (2) 6,294 (17%) ages 35–39 years, and 3) 1,364 (4%) aged 40 years and older. There were 76 women between the ages of 45 and 49 years. There were 7 women between the ages of 50 and 52 years. There were 16,297 nulliparous patients and 19,759 multiparous patients. There were 1,775 patients who indicated that their pregnancies had been secondary to assisted conception. Of these, 1,222 underwent ovulation induction without ART, while 553 underwent ART. Patient characteristics are summarized in Table 1.

The cohort was predominantly white (68%), college-educated (mean years of education was 14.3 years), and married (79%). Smokers comprised 5% of the cohort, and 38% of the women were taking medications for pre-existing conditions before pregnancy. One percent of patients had pregestational insulin-requiring diabetes. Seven percent of patients had experienced a prior preterm delivery, 26% had a previous miscarriage, and 4% had a previous pregnancy affected by an anomalous fetus (chromosomally or structurally abnormal). The



**Table 2.** Percentages of Obstetric Complications by Maternal Age

Outcome	Age < 35 y (n = 28,398)	Age 35–39 y (n = 6,294)	Age ≥ 40 y (n = 1,364)	P
Threatened abortion	13.9	15.4	19.3	< .001
Miscarriage	0.8	1.5	2.2	< .001
Chromosomal abnormality	0.2	0.8	1.9	< .001
Congenital anomaly	1.7	2.8	2.9	< .001
Gestational hypertension	4.7	4.1	5.5	.034
Preeclampsia	2.4	2.3	3.0	.422
Gestational diabetes	2.9	5.3	7.3	< .001
Placenta previa	0.5	0.9	1.9	< .001
Placental abruption	0.7	0.8	1.6	< .001
Preterm labor	5.3	5.2	5.3	.883
PPROM	1.5	1.8	2.3	.238
Preterm delivery	7.8	8.6	11.8	.002
Low birth weight	5.2	5.1	7.5	< .001
Macrosomia > 4,500 g	1.1	1.8	1.2	< .001
Operative vaginal delivery	7.5	7.1	6.3	.111
Cesarean delivery	21.7	31.4	40.5	< .001
Perinatal loss	0.3	0.3	0.7	.079

PPROM, preterm premature rupture of membranes.

Data are presented as percentage of cases.

profiles of the 3 age groups were not uniform. The older patients were more likely to be white ( $P < .001$ ), multiparous ( $P < .001$ ), and married ( $P < .001$ ). They were also more likely to have pregestational diabetes ( $P < .001$ ) and chronic hypertension ( $P < .001$ ) and to be taking medications for pre-existing medical conditions ( $P < .001$ ). Older women were also significantly more likely to have a history of miscarriage ( $P < .001$ ) and preterm birth ( $P < .001$ ) and to have had a prior pregnancy complicated by a chromosomally or structurally

abnormal fetus ( $P < .001$ ). They were also more likely to have used assisted reproductive care during this pregnancy ( $P < .001$ ).

Tables 2 and 3 summarize the results for each adverse pregnancy outcome. Table 2 indicates the percentage of affected cases for each obstetric outcome for all patients and for each maternal age group. Table 3 presents the adjORs with 95% CIs estimating the effect of advanced maternal age compared with the referent group, women aged less than 35 years, for each of the obstetric outcomes.

**Table 3.** Obstetric Complications by Maternal Age: Adjusted Models\*

Outcome	Age 35–39 vs Referent Group <sup>†</sup>		Age ≥ 40 vs Referent Group <sup>†</sup>	
	AdjOR (95% CI)	P	AdjOR (95% CI)	P
Threatened abortion	1.0 (0.9–1.1)	.65	1.1 (0.9–1.3)	.31
Miscarriage	2.0 (1.5–2.6)	< .001	2.4 (1.6–3.6)	< .001
Chromosomal abnormality	4.0 (2.5–6.3)	< .001	9.9 (5.8–17.0)	< .001
Congenital anomaly	1.4 (1.1–1.8)	.003	1.7 (1.2–2.4)	.002
Gestational hypertension	0.8 (0.7–1.0)	.02	1.0 (0.8–1.4)	.94
Preeclampsia	0.9 (0.7–1.2)	.60	1.1 (0.7–1.6)	.81
Gestational diabetes	1.8 (1.5–2.1)	< .001	2.4 (1.9–3.1)	< .001
Placenta previa	1.8 (1.3–2.6)	.001	2.8 (1.6–4.6)	< .001
Placental abruption	1.3 (0.9–1.8)	.21	2.3 (1.3–3.8)	.002
Preterm labor	0.9 (0.8–1.0)	.15	0.9 (0.7–1.2)	.39
PPROM	1.2 (0.9–1.5)	.20	1.2 (0.8–1.9)	.41
Preterm delivery	1.0 (0.9–1.1)	.61	1.4 (1.1–1.7)	.001
Low birth weight	1.1 (0.9–1.3)	.17	1.6 (1.3–2.1)	< .001
Macrosomia > 4,500 g	1.4 (1.1–1.8)	.004	0.8 (0.4–1.4)	.38
Operative delivery	1.1 (0.9–1.2)	.57	0.9 (0.7–1.2)	.54
Cesarean delivery	1.6 (1.5–1.7)	< .001	2.0 (1.8–2.3)	< .001
Perinatal loss	1.1 (0.6–1.9)	.74	2.2 (1.1–4.5)	.03

AdjOR, adjusted odds ratio; CI, confidence interval; PPRM, preterm premature rupture of membranes.

\* Adjusted models controlled for the effects of site, race, parity, body mass index, education, marital status, smoking, pre-existing medical condition, previous adverse pregnancy outcome, and use of assisted conception.

<sup>†</sup> Referent group includes all patients aged less than 35 years at expected date of delivery.





There were no clinically significant differences noted between the groups with regard to gestational age at delivery or birth weight. The mean gestational age at delivery was  $39.1 \pm 2.7$  weeks for all patients,  $39.1 \pm 2.5$  weeks for group 1,  $39.0 \pm 3.1$  weeks for group 2, and  $38.7 \pm 3.7$  weeks for group 3. The mean birth weight was  $3,348 \pm 538$  g for all patients,  $3,341 \pm 531$  g for group 1,  $3,385 \pm 557$  g for group 2, and  $3,331 \pm 588$  g for group 3.

As anticipated, advancing maternal age was significantly associated with an increased risk for miscarriage (adjOR 2.0, 95% CI 1.5–2.6; adjOR 2.4, 95% CI 1.6–3.6, for ages 35–39 years and  $\geq 40$  years, respectively) and chromosomal abnormalities (adjOR 4.0, 95% CI 2.5–6.3; adjOR 9.9, 95% CI 5.8–17.0). Advancing maternal age was also significantly associated with fetal/neonatal congenital anomalies (adjOR 1.4, 95% CI 1.1–1.8; adjOR 1.7, 95% CI 1.2–2.4), gestational diabetes (adjOR 1.8, 95% CI 1.5–2.1; adjOR 2.4, 95% CI 1.9–3.1), placenta previa (adjOR 1.8, 95% CI 1.3–2.6; adjOR 2.8, 95% CI 1.6–4.6), and cesarean delivery (adjOR 1.6, 95% CI 1.5–1.7; adjOR 2.0, 95% CI 1.8–2.3). Patients aged 35–39 years were at increased risk for macrosomia (adjOR 1.4, 95% CI 1.1–1.8). In addition, age greater than 40 years at delivery was significantly associated with placental abruption (adjOR 2.3, 95% CI 1.3–3.8), preterm delivery (adjOR 1.4, 95% CI 1.1–1.7), low birth weight (adjOR 1.6, 95% CI 1.3–2.1), and perinatal mortality (adjOR 2.2, 95% CI 1.1–4.5). No statistically significant differences were noted among the groups for threatened abortion, gestational hypertension, preeclampsia, preterm labor, preterm PROM, and assisted vaginal delivery.

## DISCUSSION

The impact that the decision to delay childbearing has on maternal and perinatal outcomes becomes increasingly relevant as more and more women postpone having children until they are over the age of 35. There are numerous reports in the literature assessing the effect of advancing maternal age on pregnancy outcomes, but results are varied.<sup>2–31</sup> The majority of studies are optimistic with regard to maternal and neonatal outcomes.<sup>2,3,33</sup> Unlike the majority of other studies, the study described here is a contemporary, large, prospective study of unselected patients with singletons, which was conducted over a narrow period of time with approximately 98% ascertainment of outcome data. Most importantly, potential confounding factors to the relationship between advancing maternal age and the obstetric outcomes, including race, parity, BMI, education, marital status, smoking, pre-existing medical conditions, previous adverse pregnancy outcomes, use of assisted

conception, and patient's study site, were considered separately.

Our investigation found that both maternal and perinatal outcomes are favorable for women of advancing maternal age. For the most part, patients aged 35 and older deliver at term with birth weights comparable to infants born to women aged less than 35 years at delivery. We did not find a statistically significant association between maternal age 35 or older and increased risk for threatened abortion, gestational hypertension, preeclampsia, preterm labor, preterm PROM, and operative vaginal delivery. Nonetheless, advancing maternal age is statistically associated with a small number of adverse outcomes even after controlling for race, parity, BMI, education, marital status, smoking, pre-existing medical conditions, previous adverse pregnancy outcomes, use of assisted reproductive care, and patient's study site. As would be expected, maternal age greater than 35 years and maternal age 40 years and older at delivery are both associated with an increased risk for miscarriage (adjORs 2.0 and 2.4, respectively) and for chromosomal abnormalities (adjORs 4.0 and 9.9, respectively). Ages 35–39 years were associated with a statistically significant increased risk for fetal/neonatal congenital anomalies, gestational diabetes, placenta previa, macrosomia, and cesarean delivery. The clinical significance of these associations in practice is less clear because, although  $P$  was  $< .05$ , the adjOR was not greater than 2.0. That is, while women aged 35–39 years were significantly more likely to experience one of these outcomes statistically, the level of increased risk was not overly large and should be interpreted cautiously. Maternal age 40 years and older at delivery, on the other hand, was an independent risk factor for gestational diabetes (adjOR 2.4), placenta previa (adjOR 2.8), placental abruption (adjOR 2.3), cesarean delivery (adjOR 2.0), and perinatal mortality (adjOR 2.2). The magnitude of these odds ratios would suggest that these findings are not only statistically significant, but also are likely to be clinically meaningful. Increased risks for fetal/neonatal congenital anomalies, preterm delivery, and low birth weight were statistically associated with age 40 years and older, but the clinical significance of these associations is less clear because the adjOR was not greater than 2.0.

This study is a large report of pregnancy outcomes in patients 40 years and older, including outcomes for 1,364 patients in this age group. Gilbert et al<sup>14</sup> reported on 24,032 cases but their study was limited by the fact that it was a retrospective study based on birth certificate and hospital discharge record data from the period 1992–1993. Bianco et al<sup>2</sup> performed a study on 1,404 patients 40 years and older who delivered during the



period 1988–1994. The latter study was limited by the fact that it was retrospective and studied a select population of patients with private medical insurance.

More recently, a birth certificate review from Sweden by Jacobsson et al<sup>34</sup> reported pregnancy outcomes on a large cohort of older patients who delivered between 1987 and 2001. This study suggested an increased risk of developing severe preeclampsia with advancing maternal age but a decreased risk of developing mild preeclampsia. The authors could not explain this apparent contradiction. Rates of gestational hypertensive diseases in the control and study groups were lower than expected, calling into question the completeness of case ascertainment and so the applicability of the findings. In addition, the Swedish study disregarded outcome information on adverse events, including fetal loss, occurring before 28 weeks of gestation and did not control for use of in vitro fertilization. In contrast, our study did not suffer from the limitations of birth certificate studies and controlled for relevant confounding factors, including use of assisted conception. Furthermore, although our patients derived from those who were able to obtain prenatal care beginning in the first trimester, our patient population was diverse, coming from 15 medical centers throughout the United States. Therefore, our results more likely reflect the contemporary heterogeneous patient population in the United States.

An interesting aspect of this study was that we did not find advancing maternal age to be associated with a statistically significant increased risk for hypertensive complications of pregnancy such as gestational hypertension (adjOR 0.8 and 1.0, for women aged 35–39 and those aged  $\geq 40$  years, respectively) or preeclampsia (adjOR 0.9 and 1.1, for ages 35–39 and  $\geq 40$  years, respectively). These findings regarding hypertensive complications in pregnancy are in contrast to many other reports.<sup>2–5,7,14,18,21,23,25,26,28,30,35</sup> Although there have been studies suggesting that advancing maternal age may not be associated with a statistically significant increased risk for hypertensive complications, these reports were limited by small numbers of patients.<sup>19,24,31</sup> Our study controlled for covariates associated with gestational hypertension and preeclampsia, including parity, history of medical conditions, and use of assisted reproductive care. As a result, our findings suggest that although chronic hypertension is more common with advancing maternal age, age alone is not responsible for gestational hypertensive complications. It is important to note that our study did not include enough women older than 45 years and older than 50 years to draw any statistical conclusions about rates of gestational hypertension and preeclampsia in women of these age groups. The effect of egg donation on rates of gestational hyper-

tensive complications also could not be discerned. Hypertensive complications of pregnancy may be more common in these patients. Seven percent of these women older than 45 years were diagnosed with gestational hypertension, while 11% had preeclampsia.

Other findings in our study are consistent with previous studies. It is well established that advancing maternal age is associated with an increased risk for miscarriage and fetal chromosomal abnormalities.<sup>5</sup> In patients aged 40 years and older, the higher incidence of antepartum complications such as miscarriage, gestational diabetes, placenta previa, and placental abruption have been documented in the literature.<sup>2,13,14,21,23,30,36,37</sup> The increased incidence of miscarriage is thought to be secondary to the increased risk of chromosomal abnormalities in these pregnancies. The increased risk of gestational diabetes and placenta previa may be secondary to the relationship between aging and progressive vascular endothelial damage.<sup>2,23,38</sup> Studies regarding an increased risk for perinatal mortality in women of advanced maternal age have been controversial.<sup>2,3,11,14,21,26,28,31,39</sup> In this study, the increased risk of perinatal mortality was not statistically significant for patients aged 35–39 years (adjOR 1.1). Age 40 years and older was associated with a statistically significant increased risk of perinatal loss (adjOR 2.2). There were only 119 stillbirths and 37 neonatal demises in total. As a result, we could not draw any meaningful conclusions about the etiology or timing of perinatal mortality in women of advancing maternal age. The reason that advanced-maternal-age patients may be at increased risk of perinatal mortality is unknown.<sup>40</sup> The failure of uterine vasculature to adapt to the increased hemodynamic demands of pregnancy as women age is a proposed explanation.<sup>23</sup>

As with prior literature, this study demonstrated that women aged 40 years and older are at increased risk for cesarean delivery.<sup>2,13,14,21,22,26–28,30,31</sup> Older women may be at increased risk for abnormalities of the course of labor, perhaps secondary to the physiology of aging. It is possible that decreased myometrial efficiency occurs with aging.<sup>2,12</sup> Nonetheless, maternal age alone may be a factor influencing physician decision making.<sup>24</sup> It is uncertain whether the increased rates of cesarean delivery are due to a real increase in the prevalence of obstetric complications or whether there is a component of iatrogenic intervention secondary to both physician and patient attitudes toward pregnancy in this older patient population.<sup>2,5,41–43</sup>

It is important to note that the findings of this study may not be generalized to every advanced-maternal-age obstetric patient in the United States. Although the FASTER trial patient population was unselected, meaning that patients were not excluded based on any con-



founding factors such as race, parity, BMI, education, marital status, smoking, pre-existing medical conditions, previous adverse pregnancy outcomes, and use of assisted reproductive care, there may have been significant patient or provider self-selection. Patients could only enroll in the study if they started antepartum care in the first trimester and if they received care at a facility participating in the FASTER trial.

In summary, the majority of women of advanced maternal age deliver at term without maternal or perinatal adverse outcomes. Advancing maternal age does not appear to be associated with hypertensive complications such as gestational hypertension and preeclampsia. Nonetheless, as women become older, they become increasingly prone to perinatal complications above and beyond the medical complications concomitant with aging. This study better defines the importance of both counseling and following patients for specific adverse outcomes associated with advancing maternal age. Patients aged 35 years and older are at an increased risk for miscarriage and fetal chromosomal abnormalities, many of which may be diagnosed prenatally. Age 40 years and older is an independent risk factor for gestational diabetes, placenta previa, placental abruption, cesarean delivery, and perinatal mortality. The role of routine antenatal surveillance in women aged 40 years and older requires further investigation because these women seem to be at increased risk for perinatal mortality, including stillbirth. Although the likelihood of adverse outcomes increases along with maternal age, patients and obstetric care providers can be reassured that overall maternal and fetal outcomes are favorable in this patient population.

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## APPENDIX

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