

OBSTETRICS

Maternal and newborn morbidity by birth facility among selected United States 2006 low-risk births

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OBJECTIVE: We sought to evaluate perinatal morbidity by delivery location (hospital, freestanding birth center, and home).

STUDY DESIGN: Selected 2006 US birth certificate data were accessed online from the Centers for Disease Control and Prevention. Low-risk maternal and newborn outcomes were tabulated and compared by birth facility.

RESULTS: A total of 745,690 deliveries were included, of which 733,143 (97.0%) occurred in hospital, 4661 (0.6%) at birth centers, and 7427 (0.9%) at home. Compared with hospital deliveries, home and birthing center deliveries were associated with more frequent pro-

longed and precipitous labors. Home births experienced more frequent 5-minute Apgar scores <7. In contrast, home and birthing center deliveries were associated with less frequent chorioamnionitis, fetal intolerance of labor, meconium staining, assisted ventilation, neonatal intensive care unit admission, and birthweight <2500 g.

CONCLUSION: Home births are associated with a number of less frequent adverse perinatal outcomes at the expense of more frequent abnormal labors and low 5-minute Apgar scores.

Key words: birthing center, home birth, perinatal outcome

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Almost 1 in 200 US women giving birth does so at home, accounting for approximately 25,000 deliveries annually.¹ Two-thirds of these deliveries were attended by a physician or midwife, suggesting that home birth represented a conscious choice by the majority of these mothers. Home birth policy statements by several professional organizations are surprisingly discordant despite considering the same body of evidence, most of which comes from European studies.

The American College of Obstetricians and Gynecologists (ACOG) “strongly opposes home births,” citing a lack of scientific rigor in studies comparing the safety and outcomes of US hospital births to those occurring elsewhere.² In support of home birth, the American College of Nurse Midwives notes that “high-quality controlled trials and de-

scriptive studies have established that planned home births achieve excellent perinatal outcomes” while decreasing the use of potentially harmful medical interventions.³ Finally, the Association of Women’s Health, Obstetric, and Neonatal Nurses “supports a woman’s right to choose and have access to a full range of providers and settings for pregnancy, birth, and women’s health care.”⁴

In the absence of professional consensus and adequate US data regarding the safety and outcomes of home birth, we sought to compare maternal and newborn morbidity by delivery location among women at low obstetric risk.

MATERIALS AND METHODS

This investigation is a retrospective population-based cohort study using US 2006 birth data files at the state level, which were accessed online at the Centers for Disease Control and Prevention (CDC) National Center for Health Statistics (<http://www.cdc.gov/nchs/datawh/vitalstats/VitalStatsbirths.htm>). Demographics and maternal and newborn outcomes were selected from the 2003 revision of the US Standard Certificate of Live Birth, used by 19 states and representing 49% of all US births. These states were California, Delaware, Flor-

ida, Idaho, Kansas, Kentucky, Nebraska, New Hampshire, New York (excluding New York City), North Dakota, Ohio, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Vermont, Washington, and Wyoming.

To identify a low obstetrical risk population, we excluded multiple gestations, preterm deliveries <37 weeks, smokers, women with pregestational or gestational diabetes, chronic hypertension, hypertensive disorders of pregnancy, or prior cesarean. Demographics included maternal age, race, education, and timeliness of registering for prenatal care. Maternal morbidity measures in this low-risk population included chorioamnionitis (clinical diagnosis of chorioamnionitis during labor made by delivery attendant, usually includes >1 of the following: fever, uterine tenderness and/or irritability, leukocytosis, fetal tachycardia, any maternal temperature $\geq 38^{\circ}\text{C}$ [100.4°F]), fetal intolerance of labor (in utero resuscitative measures, eg, any of the following: maternal position change, oxygen administration to the mother, intravenous fluids administered to the mother, amnioinfusion, support of maternal blood pressure, and administration of uterine relaxing agents; further fetal assessment includes any of the fol-

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lowing: scalp pH, scalp stimulation, acoustic stimulation; operative delivery is operative intervention to shorten time to delivery of the fetus, eg, forceps, vacuum, or cesarean delivery), prolonged labor (labor that progresses slowly and lasts for ≥ 20 hours), precipitous labor (labor that progresses rapidly and lasts for < 3 hours), and meconium staining (staining of the amniotic fluid caused by passage of fetal bowel contents during labor and/or at delivery that is more than enough to cause a greenish color change of an otherwise clear fluid). Newborn morbidity included assisted ventilation (infant given manual breaths for any duration with bag and mask or bag and endotracheal tube within the first several minutes from birth, excludes oxygen only and laryngoscopy for aspiration of meconium), assisted ventilation > 6 hours (infant given mechanical ventilation [breathing assistance] by any method for > 6 hours, includes conventional, high-frequency, and/or continuous positive pressure), birth injury (defined as present immediately following delivery or manifesting soon after delivery, includes any bony fracture or weakness or loss of sensation but excludes fractured clavicles and transient facial nerve palsy; soft tissue hemorrhage requiring evaluation and/or treatment, includes subgaleal [progressive extravasation within the scalp] hemorrhage, giant cephalohematoma, extensive truncal, facial, and/or extremity ecchymosis accompanied by evidence of anemia and/or hypovolemia and/or hypotension; solid organ hemorrhage, includes subcapsular hematoma of the liver, fractures of the spleen, or adrenal hematoma), neonatal intensive care unit (NICU) admission (admission into a facility or unit staffed and equipped to provide continuous mechanical ventilatory support for a newborn), seizures (seizure is any involuntary repetitive, convulsive movement or behavior; serious neurologic dysfunction is severe alteration of alertness, such as obtundation, stupor, or coma, ie, hypoxic-ischemic encephalopathy, excludes lethargy or hypotonia in the absence of other neurologic findings, excludes symptoms associated with central nervous system

congenital anomalies), 5-minute Apgar score < 7 , and birthweight < 2500 g.⁵

Custom tables were generated using the online Vital Stats software (Victoria, Australia), comparing demographic characteristics and morbidity measures by delivery location (hospital, freestanding birthing center, or residence). Data were analyzed by the χ^2 test with Bonferroni correction, using $P < .003$ as significant. Descriptive statistics included odds ratios with 95% confidence intervals and rates expressed as occurrences per 1000 births. Outcomes recorded as “not stated” were tabulated but not included in denominators for statistical analysis.

RESULTS

There were 4,265,555 births reported in 2006, of which 2,073,368 (48.6%) used the 2003 US birth certificate and 745,690 (17.5%) met inclusion criteria. Of these births, 733,143 (97.0%) occurred in hospitals, 4661 (0.6%) in birth centers, and 7427 (0.9%) at home. Physicians delivered 678,234 infants in hospital, 620 in freestanding birthing centers, and 295 at home. Certified nurse midwives attended 51,555 in-hospital births, 2067 freestanding birthing center deliveries, and 1786 home births. Other midwives delivered 634 infants in hospital, 1865 in freestanding birthing centers, and 3521 at home. The remaining birth attendants were categorized as “not stated” or “other” ($n = 4801$; 0.6%). Physicians or midwives attended 5602 of 7427 (75.4%) home births, suggesting that the majority of home deliveries were planned. Subject demographics are presented in Table 1. Compared with women delivering in hospital, those delivering in freestanding birthing centers or at home were more often older, multiparous, and white, with less formal education and later registration for prenatal care. Maternal and newborn outcomes are presented in Table 2. Outcomes were missing for 0.1–1.7% of births, depending on the measure. Compared with women delivering in hospitals, those giving birth in birth centers or at home had more frequent prolonged and precipitous labors. Home births were also associated with

higher rates of low 5-minute Apgar scores. In contrast, home and birthing center deliveries were associated with less chorioamnionitis, fetal intolerance of labor, meconium staining, assisted ventilation, NICU admissions, and birthweight < 2500 g. There were no differences in assisted ventilation > 6 hours, neonatal seizures, or birth injury rates by delivery location.

COMMENT

Despite current ACOG policy, home birth remains the choice of a small proportion of US women. Therefore, we sought to further examine maternal and newborn morbidity by delivery location among selected US low-risk births. Our study demonstrates that home delivery is associated with significantly increased rates of abnormal labor progress and depressed 5-minute Apgar scores, consistent with earlier reports.^{6,7} We chose to examine a selected low-risk population, as candidates for out-of-hospital births typically exhibit low obstetric risk.^{7,8} It is notable that this cohort experienced significantly higher rates of an outcome, low 5-minute Apgar scores, potentially requiring neonatal resuscitation in comparison to a presumably higher-risk group of hospital deliveries. Lack of significant differences in other morbidities by delivery location could signify out-of-hospital birth practices raising certain risks compared with those of in-hospital deliveries or hospital care reducing obstetric risk in a complicated population.⁹

In addition, lower rates of chorioamnionitis, meconium staining, assisted ventilation, NICU admission, and birthweight < 2500 g among out-of-hospital births likely reflect selection criteria of candidates for these delivery options. Alternatively, since most home deliveries are attended by midwives, some of these observations may reflect improved outcomes related to such practice models.¹⁰ Likewise, such practice pattern differences may explain the seemingly contradictory findings of more frequent prolonged labor but decreased rate of chorioamnionitis and fetal intolerance of labor among home births. Randomized trials of midwife-led care models are

TABLE 1
Maternal demographics by delivery location

Demographic	Hospital (n = 733,143)		Freestanding birthing center (n = 4661)		Residence (n = 7427)		P
	n	%	n	%	n	%	
Age, y							< .0001
<20	87,177	11.9	184	3.9	168	2.3	
20–29	401,807	54.1	2642	56.7	3749	50.5	
30–39	230,546	31.4	1701	36.5	3122	42.0	
≥40	13,613	1.9	134	2.9	388	5.2	
Parity							< .0001
Nulliparous	277,421	37.9	1154	24.7	1136	15.3	
Parous	444,480	60.6	3476	76.6	6070	81.7	
Race							< .0001
White	600,885	81.9	4429	95.0	7014	94.4	
Black	97,091	13.2	138	3.0	294	4.0	
American Indian	4887	0.7	18	0.4	24	0.3	
Asian/Pacific Islander	30,676	4.2	76	1.6	95	1.3	
Education							
≤12th grade	154,083	21.0	1740	37.3	2920	39.3	
High school graduate	323,317	44.1	1334	28.6	2289	30.8	
College degree	252,383	34.4	1578	33.9	2179	29.3	
Initiation of prenatal care							
First–third mo	496,240	67.7	2223	47.7	2899	39.0	< .0001
Fourth–sixth mo	159,293	21.7	1709	36.7	3092	40.4	
Seventh–tenth mo	39,213	5.3	662	14.2	926	12.5	
No prenatal care	14,411	2.0	24	0.5	359	4.8	

Wax. Morbidity by birth facility among selected United States 2006 low-risk births. *Am J Obstet Gynecol* 2010.

associated with fewer medical interventions, such as labor induction, electronic fetal heart rate monitoring, regional anesthesia, episiotomy, operative vaginal delivery, and cesarean delivery.¹⁰ The dataset used for our study also showed significantly less frequent labor augmentation and induction among home births (data not shown). Thus, fewer intrapartum interventions, several of which are risk factors for fever and chorioamnionitis, may contribute to the lower infection rates reported among home births. Similarly, one would expect fewer diagnoses of fetal intolerance of labor when electronic fetal heart rate monitoring is used less frequently, as in midwife-led care and home birth.^{10–12}

The demographics of the cohort varied significantly by delivery location, raising the issue of bias arising from self-selection. Such differences are not unexpected, considering that women choosing an out-of-hospital birth exhibit markedly different personality traits and expectations for their childbirth experience than mothers planning hospital deliveries.^{13–18} We noted that women planning home births are more often multiparous, older, and white than mothers delivering in hospital, consistent with 2 earlier larger US cohort studies.^{11,19}

Recognizing that demographic differences may have influenced our findings, such effects could be accounted for by

adjusting the morbidity measures' odds ratios. However, adjustment would require patient-level data that were not available for age, education, and initiation of prenatal care. Moreover, the impact of adjustment would be questionable, considering the frequency of adverse outcomes among the home births. We suggest that clinical relevance resides in the maternal and newborn outcomes observed by delivery location, regardless of the intrinsic demographic differences among women choosing particular birth options.

We recognize several limitations of our study related to birth certificate data. Specifically, completion rates and accuracy typically result in underascertain-

TABLE 2

Maternal and newborn outcomes by birth facility, United States, 2006

Outcome	Hospital (referent) (n = 733,143)		Birthing center (n = 4661)			Residence (n = 7427)			P
	n	Rate/1000	n	Rate/1000	OR (95% CI)	n	Rate/1000	OR (95% CI)	
Maternal outcome									
Chorioamnionitis	8783	11.9	1	^a	0.02 (0.00–0.13)	2	^a	0.02 (0.01–0.09)	< .0001
Fetal intolerance of labor	39,409	53.8	7	^a	0.03 (0.01–0.06)	12	^a	0.03 (0.02–0.05)	< .0001
Prolonged labor	8053	11.0	111	23.8	2.19 (1.81–2.65)	225	30.4	2.81 (2.46–3.22)	< .0001
Precipitous labor	20,948	28.6	284	60.9	2.20 (1.95–2.48)	755	101.9	3.84 (3.56–4.15)	< .0001
Meconium staining	34,907	47.6	83	17.8	0.36 (0.29–0.45)	175	23.6	0.48 (0.41–0.56)	< .0001
Newborn outcome									
Assisted ventilation	30,181	41.3	98	1.72	0.49 (0.41–0.61)	168	22.6	0.54 (0.46–0.63)	< .0001
Assisted ventilation >6 h	2636	3.6	6	^a	0.36 (0.16–0.79)	12	^a	0.45 (0.25–0.79)	.01
Birth injury	440	0.6	3	^a	1.10 (0.34–3.33)	4	^a	0.89 (0.33–2.40)	.97
NICU admission	18,785	25.7	23	4.9	0.19 (0.12–0.28)	85	11.5	0.44 (0.35–0.54)	< .0001
Seizures	165	0.2	2	^a	1.89 (0.47–7.66)	2	^a	1.19 (0.30–4.81)	.64
5-min Apgar score <7	9018	12.4	48	10.5	0.83 (0.63–1.11)	157	23.5	1.92 (1.63–2.25)	< .0001
Birthweight <2500 g	16,413	22.4	36	7.7	0.34 (0.24–0.47)	83	11.3	0.50 (0.40–0.62)	< .0001

CI, confidence interval; NICU, neonatal intensive care unit; OR, odds ratio.

^a Figure does not meet standards of reliability or precision; based on <20 births in the numerator.

Wax. Morbidity by birth facility among selected United States 2006 low-risk births. *Am J Obstet Gynecol* 2010.

ment of prenatal and intrapartum complications. As noted earlier, completion rates for evaluated outcomes were quite high, although the accuracy of the reported data could not be assessed. This potential bias would likely underestimate risks associated with both home and hospital births in our investigation. Moreover, up to 20% of all planned home births and 25% of planned home births among nulliparous women require unplanned intrapartum transfer to hospital for delivery.^{14,20} Thus, complications necessitating transfer or resulting from deliveries following transfer from home are attributed to hospital rather than home births, further underestimating risks associated with intended home birth. The 2003 revised birth certificate has the ability to note whether a mother was transported antepartum to the delivering hospital from another birthing facility or hospital but not from home. In addition, home deliveries can be coded as planned or unplanned. This information was unavailable in our dataset. Nonetheless, our results conservatively estimate that at least three-quar-

ters of women delivering at home chose to do so, evidenced by a designated caregiver in attendance. The net effect of these phenomena is unclear and suggests some caution when interpreting our findings. Furthermore, we note that our data are drawn from the 49% of 2006 US births that were reported from 19 states using the 2003 revised birth certificate, rather than the entire US birth set. This approach was taken to ensure comparability of reported outcomes across subjects.¹ As the reporting states are geographically diverse and still provide a large study population, we do not believe that this limitation detracts from our findings, although generalizability may be somewhat diminished.

Finally, the dataset did not consider maternal or perinatal mortality. These endpoints, while rare, arguably represent the ultimate measures of childbirth safety. Earlier investigations reported no maternal deaths among home birth cohorts too small to meaningfully address this extremely uncommon outcome.^{7,14,20} Importantly, 3 studies suggest higher perinatal mortality rates

among planned home births compared with planned hospital births.^{7,21,22} Existing CDC databases, once updated, could be queried to address these critically important outcomes.

The current study offers several strengths. The large cohort of contemporary US births provides a robust evaluation of maternal and newborn outcomes that is generalizable and reflects actual practice. The large number of subjects and few missing birth certificate data permitted evaluation of infrequent but clinically significant adverse outcomes among women delivering in a variety of settings. Thus, these results serve as valuable counseling tools for women considering an out-of-hospital birth.

Our findings also suggest areas for future research. Specifically, apparently improved outcomes associated with home and birthing center deliveries deserve attention and should not simply be attributed to expectations for a preselected cohort of low-risk women. Rather, demonstrated benefits of midwifery-led care models, which typically characterize out-of-hospital births, should be criti-

cally evaluated and potentially incorporated into hospital-based best-practice obstetrical care.^{10,23} Likewise, interventions potentially increasing morbidity among hospital births may warrant more selective use. Not unlike vaginal birth after cesarean or cesarean delivery on maternal request, choosing home birth likely represents balancing risks of uncommon but potentially serious complications with improved alternative outcomes framed by women's expectations for childbirth.^{24,25} This study and suggested future investigations are useful in identifying and quantifying the relative advantages and risks of hospital vs out-of-hospital childbirth. ■

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