

# Birth Outcomes of Women Using a Midwife versus Women Using a Physician for Prenatal Care

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**Introduction:** Few studies have compared midwife-led and physician-led care in the United States. Our objective was to compare the frequency of birth interventions and maternal and neonatal outcomes between women who received prenatal care from a midwife and those who received care from a physician, among women who were low risk when they initiated prenatal care.

**Methods:** We performed a retrospective cohort study of women giving birth at a large public hospital who had at least one prenatal visit before 20 weeks' gestation in the years 2012 through 2015. We classified women according to prenatal care provider type (midwife vs physician) at first prenatal visit and compared birth outcomes between the groups, using intent-to-treat analyses. We used modified Poisson regression to calculate adjusted risk ratios (aRRs) for common outcomes and logistic regression with Firth's bias correction to produce adjusted odds ratios (aORs) for rare outcomes. As a sensitivity analysis, we performed a matched propensity score analysis to account for potential confounding by indication.

**Results:** Midwives provided care to 8.2% of the women; physicians provided care to 91.8% of the women. Women in midwifery care were less likely to be black, have Medicaid insurance, or have a history of pregnancy complications or previous cesarean births compared with women who received care from physicians. Women in midwifery care had lower risks of cesarean (aRR, 0.66; 95% CI, 0.57-0.78) and preterm birth (aRR, 0.58; 95% CI, 0.42-0.79), with no increased odds of neonatal intensive care unit admissions, neonatal deaths, or severe maternal morbidity. Women in midwifery care had increased odds of postpartum hemorrhage and shoulder dystocia (aOR, 3.26; 95% CI, 1.40-7.58, and aOR, 1.80; 95% CI, 1.01-3.22, respectively); however, these did not remain significant in the propensity score analysis.

**Discussion:** Among women with low-risk pregnancies, midwifery care was associated with substantially fewer preterm births and labor interventions.

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**Keywords:** midwifery, prenatal care, birth outcomes, cesarean birth

## INTRODUCTION

Midwifery and obstetrics are separate but complementary professions, and each provides a unique approach to the care of women during pregnancy and birth. Midwives treat women as part of a multilevel perinatal team and are experts in normal, physiologic pregnancy and birth, providing a holistic approach to the care of women during pregnancy.<sup>1,2</sup>

Maternity care in the United States includes costly and sometimes unnecessary interventions. Many interventions, including electronic fetal heart rate monitoring during labor, induction of labor, and cesareans, commonly occur despite a substantial gap between clinical standards of practice and scientific evidence of their benefit.<sup>3</sup> Although there has been a slight decrease in recent years, the cesarean rate in the United States remains high at 32% of all births.<sup>4</sup>

Studies from other countries where midwifery is more common show that for women with low-risk pregnancies, midwifery care is associated with fewer interventions and no adverse effects for women and infants compared with physician-led care.<sup>5,6</sup> However, less is known about the effect midwives have on birth outcomes within the US health care system, which is vastly different from other countries'. Many of the studies that have assessed midwives' effect on birth

outcomes in the United States have compared birth outcomes of women who intend to give birth at home or at a birth center with those who intend to give birth in a hospital.<sup>7-11</sup> Few studies have directly compared birth outcomes of physician and midwife births.<sup>12-15</sup> A recent review article comparing outcomes of certified nurse-midwives and physicians found that care provided by certified nurse-midwives was safe and compared favorably to the care of physicians; however, most of the studies included in the review used data that were more than 20 years old.<sup>16</sup> During this time, much has changed in the patterns of birth, including a substantial increase in cesareans and a decrease in episiotomies.<sup>17,18</sup> A recent ecologic study in the United States found a correlation between living in a state that has autonomous certified nurse-midwife practice and having lower rates of cesarean and preterm birth,<sup>19</sup> providing initial support for the role midwives may play in providing care associated with fewer interventions during labor and birth. Potential adverse outcomes that may be associated with less use of interventions experienced by women who receive midwifery care in the United States are not often studied.<sup>10,11</sup>

The objective of our study was to compare birth interventions, maternal outcomes, and neonatal outcomes between women with a low-risk pregnancy who received prenatal care from midwives and those who received prenatal care from physicians. Prior studies on this topic have often focused on women whose births are attended by a midwife. These women, who remain in the care of a midwife throughout birth, may be inherently less likely to experience interventions,

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## Quick Points

- ◆ Although studies from outside the United States have found midwifery care to be associated with fewer interventions and no adverse effects, few studies have assessed this association within the US health care system.
- ◆ Our retrospective cohort study found that the risks of cesarean and preterm birth were significantly lower among women who initiated prenatal care with a midwife compared with those who initiated prenatal care with a physician.
- ◆ We did not find evidence of increased adverse neonatal outcomes among the midwife group; however, our study was not powered to find small differences in rare neonatal outcomes.
- ◆ Our study provides further evidence that midwives provide a safe alternative to physician prenatal care and that midwifery care may lead to a lower cesarean birth rate.

particularly cesareans, compared with women who had to transfer to the care of a physician at some point during their pregnancies. Therefore, we used an intent-to-treat approach to assess outcomes of midwife care, eliminating this concern.

### METHODS

#### Data Source

In our retrospective observational cohort study, we included women who gave birth to a singleton infant between January 2012 and December 2015 at The Ohio State University Wexner Medical Center (OSUWMC), who had attended at least one prenatal care visit within the OSUWMC network with either a physician or a midwife prior to 20 weeks' gestation, and who fit our definition of having a low-risk pregnancy at the time the woman initiated prenatal care. For women who gave birth more than once within the study period, we included only the first birth and the prenatal visits associated with that birth ( $n = 10,188$ ). We assembled the cohort with data retrieved from OSUWMC's electronic health records for all prenatal care visits and births.

We limited our analysis to low-risk women who potentially could have seen a midwife for prenatal care at the time they initiated care. To create a low-risk cohort, we excluded women if they had any of the following pre-existing conditions, using ICD-9 codes: active seizure disorder, active tuberculosis, acute hepatitis, advanced syphilis, cardiac disease, HIV infection, hydatidiform mole, indication of cocaine or unprescribed opiates and benzodiazepines use, systemic lupus erythematosus, pre-existing diabetes, previous vertical uterine incision, renal disease, sickle-cell disease, status asthmaticus, and treatment with methadone or buprenorphine/naloxone (Suboxone) ( $n = 1266$ ). These criteria were based on the OSUWMC midwives' clinical guidelines on indications for required transfers of care (Rebecca Wagner, CNM, written communication, October 2015), and such women would not have been eligible to receive midwifery care at our institution. Finally, we excluded from our analysis women who were due to give birth after December 15, 2015 ( $n = 143$ ). We excluded these women to prevent fixed cohort bias, in which births at the end of the interval are more likely to be preterm and as a result contribute disproportionately to poor birth outcomes. A total of 8779 women were included in our analysis.

#### Exposure of Interest: Prenatal Care Provider Type

Our exposure of interest was the prenatal care provider type at the initial prenatal care visit in the OSUWMC system. Women were free to choose their prenatal care provider type. Women who saw a midwife through the OSUWMC midwife clinic for their first prenatal care visit were considered to be part of the midwife cohort, and women who did not were considered part of the physician cohort. The midwifery clinic is a part of the OSUWMC, which at the time of the study consisted of a single location that served all women who were interested in using a midwife for prenatal care and giving birth at OSUWMC. The midwives in this clinic only attended births at the OSUWMC medical center and did not attend out-of-hospital births. All of the midwives in this study were certified nurse-midwives. Midwives in this clinic had full autonomy when caring for women and transferred women to the care of a physician as necessary.

The OSUWMC midwifery practice is an independent practice in which the midwives cover labor and delivery 24 hours a day, and transfers are primarily for medical indications.<sup>20</sup> Previous research on this practice has shown that 95% of women who initiated prenatal care in the midwife clinic remained in midwife care throughout prenatal care and that 75% of women remained in midwife care throughout birth. Of the women who transferred to physician care, 75% transferred because of the need for a cesarean or assisted birth.<sup>20</sup>

#### Outcomes of Interest

We assessed the following labor interventions, using data extracted from the electronic health record: labor induction (yes vs no), labor augmentation (yes, if labor was augmented with oxytocin or artificial rupture of membranes, vs no), episiotomy (yes vs no), and use of epidural analgesia during labor (yes vs no).

We assessed the following maternal birth outcomes, using data extracted from the electronic health record: cesarean birth (yes vs no), third- or fourth-degree perineal lacerations (yes vs no), postpartum hemorrhage (yes vs no), and shoulder dystocia, defined as obstructed labor in which after the birth of the head, the anterior shoulder of the neonate cannot pass below the pubic symphysis (yes vs no). As these variables were extracted from the electronic health record, we did not use a formal definition for any of these outcomes. In

addition, we used ICD-9 codes to assess severe maternal morbidity. Women were classified as having severe maternal morbidity if they experienced any of the following: acute renal failure, liver failure, respiratory failure, obstetric shock, cerebrovascular accident, pulmonary embolism, amniotic fluid embolism, eclampsia, septicemia, complications of anesthesia, or a cardiac event, and their length of stay for birth was more than 72 hours. Our definition of severe maternal morbidity was based on the definition used in a recent assessment of national severe maternal morbidity trends.<sup>21</sup>

In addition to maternal outcomes, we assessed the following neonatal birth outcomes using data extracted from the electronic health records: preterm birth (<37 weeks' gestation vs  $\geq 37$  weeks' gestation), admission to level 3 or 4 neonatal intensive care unit (NICU; yes vs no), low 5-minute Apgar score (<7 vs  $\geq 7$ ), and stillbirth or neonatal death (yes vs no).

Finally, we separated the birth interventions, maternal outcomes, and neonatal outcomes into 2 groups, common and rare outcomes, according to whether each occurred in at least 5% or in fewer than 5% of births, respectively.

### Potential Confounders

The following variables were extracted from the electronic health record and considered a priori as potential confounders: age (continuous), race, public insurance status, marital status, parity (nulliparous vs multiparous), and having a previous cesarean birth. In addition, we used ICD-9 codes to assess the following potential confounders: having previous pregnancy complications (including history of preterm labor, fetal anomaly, fetal loss [stillbirth or neonatal death], postpartum hemorrhage, preeclampsia, gestational diabetes, fourth-degree perineal laceration, or pulmonary embolism), obesity, hypertension, and smoking during pregnancy. All potential confounders were included in the adjusted models.<sup>22</sup>

### Data Analysis

Our study used an intent-to-treat model, in which women remained in the exposure category to which they were initially assigned, even if they transferred to the care of another prenatal care provider during pregnancy. This approach limited the bias that would have occurred if instead we had assessed prenatal care provider type at birth, given that women with complications during pregnancy would have been more likely to transfer to the care of a physician, thus biasing the birth outcomes in favor of midwife births.

We used descriptive statistics and contingency tables to describe the proportion of women who were cared for by a midwife and those who were cared for by a physician for the initial prenatal care visit. We used *t* tests to compare continuous variables and chi-square or Fisher's exact test to compare categorical variables as appropriate. Because odds ratios substantially overstate risk ratios when outcomes are common, we used a modified Poisson regression approach (Poisson regression with a robust error variance) to assess risk ratios of common outcomes ( $>5\%$ )<sup>23</sup> and used logistic regression with Firth's bias correction to assess odds ratios of rare outcomes. Logistic regression with Firth's bias correction was used because of its superiority over exact logistic

regression in cases in which multiple predictors are of interest and because it produces finite, consistent estimates of regression parameters when the maximum likelihood estimates do not exist because the outcome variable completely or quasi-completely separates the predictor variables.<sup>24,25</sup>

Because of the potential confounding introduced by women's self-selection into midwifery care, we performed propensity score matching as a sensitivity analysis. We assigned a propensity score to each observation based on multivariable logistic regression using all a priori potential confounders. We used a greedy 1:3 matching to match women who used a physician (unexposed) to women who used a midwife (exposed). A woman who used a midwife was matched to her closest unexposed match (among women who used a physician), using a caliper of 0.01 in the propensity score. We used conditional logistic regression with Firth's bias correction to assess the odds ratios of rare outcomes and modified conditional Poisson regression to assess risk ratios of common outcomes. We regarded *P* values less than .05 as significant. All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC). The study was reviewed and approved by The Ohio State University institutional review board.

### RESULTS

During the study period, 10,188 women gave birth, and 1409 did not meet the inclusion criteria. A total of 8779 women were included in our analysis.

Among women who entered prenatal care with a low-risk pregnancy, attended at least one prenatal visit in the OSUWMC network prior to 20 weeks' gestation, and gave birth at OSUWMC, 8.2% saw a midwife for their initial visit and 91.8% saw a physician. Women who received prenatal care from a midwife were older and were more likely to be married compared with women who received prenatal care from a physician. In addition, the proportions of women who were black, had Medicaid insurance, had hypertension, had a complication in a previous pregnancy, had a previous cesarean birth, or smoked during pregnancy were statistically significantly lower among women who saw a midwife (Table 1).

Statistically significant smaller proportions of women who received care from a midwife experienced labor induction, labor augmentation, episiotomies, or epidural analgesia compared with women who received care from a physician (Table 2). The most substantial differences in frequencies of birth outcomes (either maternal or neonatal) between women who received care from a midwife versus women who received care from a physician were in cesarean and preterm births. Although only 16.3% of women who saw a midwife for prenatal care had a cesarean birth, 30.5% of women who saw a physician for prenatal care had a cesarean birth ( $P < .001$ ). The proportion of preterm births also was significantly lower among women who received care from a midwife compared with women who received care from a physician (5.3% vs 11.4%, respectively;  $P < .001$ ).

In the regression analyses, we assessed birth interventions and outcomes separately based on whether they were common or rare outcomes. In the bivariate analysis, women who received care from a midwife had significantly reduced risks of experiencing any of the common birth interventions and

| <b>Table 1. Sociodemographic and Health Characteristics of Women Who Initiated Prenatal Care Visits by 20 Weeks' Gestation, by Initial Prenatal Care Provider Type (N = 8779)</b> |                          |                             |                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------|------------------------|
| Characteristic                                                                                                                                                                    | Midwife (n = 721), n (%) | Physician (n = 8058), n (%) | P Value <sup>a,b</sup> |
| <b>Sociodemographic Characteristics</b>                                                                                                                                           |                          |                             |                        |
| <b>Age, mean (SD), y</b>                                                                                                                                                          | 29.8 (4.6)               | 29.2 (5.8)                  | <b>.0047</b>           |
| <b>Race</b>                                                                                                                                                                       |                          |                             | <b>&lt;.0001</b>       |
| Black                                                                                                                                                                             | 67 (9.3)                 | 1892 (23.5)                 |                        |
| Other race                                                                                                                                                                        | 654 (90.7)               | 6166 (76.5)                 |                        |
| <b>Insurance type</b>                                                                                                                                                             |                          |                             | <b>&lt;.0001</b>       |
| Public (Medicaid)                                                                                                                                                                 | 175 (24.3)               | 2780 (34.5)                 |                        |
| Private                                                                                                                                                                           | 546 (75.7)               | 5278 (65.5)                 |                        |
| <b>Marital status</b>                                                                                                                                                             |                          |                             | <b>&lt;.0001</b>       |
| Married                                                                                                                                                                           | 567 (78.6)               | 4806 (59.6)                 |                        |
| Not married                                                                                                                                                                       | 154 (21.4)               | 3252 (40.4)                 |                        |
| <b>Health Characteristics</b>                                                                                                                                                     |                          |                             |                        |
| <b>Nulliparous</b>                                                                                                                                                                |                          |                             | .55                    |
| Yes                                                                                                                                                                               | 340 (47.2)               | 3706 (46.0)                 |                        |
| No                                                                                                                                                                                | 381 (52.8)               | 4352 (54.0)                 |                        |
| <b>Previous pregnancy complication<sup>c</sup></b>                                                                                                                                |                          |                             | <b>&lt;.0001</b>       |
| Yes                                                                                                                                                                               | 48 (6.7)                 | 937 (11.6)                  |                        |
| No                                                                                                                                                                                | 673 (93.3)               | 7121 (88.4)                 |                        |
| <b>Previous cesarean birth</b>                                                                                                                                                    |                          |                             | <b>&lt;.0001</b>       |
| Yes                                                                                                                                                                               | 80 (11.1)                | 1521 (18.9)                 |                        |
| No                                                                                                                                                                                | 641 (88.9)               | 6537 (81.1)                 |                        |
| <b>Obesity</b>                                                                                                                                                                    |                          |                             | .26                    |
| Yes                                                                                                                                                                               | 76 (10.5)                | 964 (12.0)                  |                        |
| No                                                                                                                                                                                | 645 (89.5)               | 7094 (88.0)                 |                        |
| <b>Hypertension</b>                                                                                                                                                               |                          |                             | .11                    |
| Yes                                                                                                                                                                               | 55 (6.0)                 | 590 (7.5)                   |                        |
| No                                                                                                                                                                                | 857 (94.0)               | 7277 (92.5)                 |                        |
| <b>Smoking during pregnancy</b>                                                                                                                                                   |                          |                             | <b>.04</b>             |
| Yes                                                                                                                                                                               | 24 (3.3)                 | 409 (5.1)                   |                        |
| No                                                                                                                                                                                | 697 (96.7)               | 8649 (94.9)                 |                        |

<sup>a</sup>T test for continuous variables,  $\chi^2$  test, or Fisher's exact test as appropriate for categorical variables.

<sup>b</sup>Bold values indicate variables significant at the .05 level.

<sup>c</sup>Previous pregnancy complication included any of the following in a previous pregnancy: preterm labor, fetal anomaly, fetal loss, postpartum hemorrhage, preeclampsia, gestational diabetes, fourth-degree perineal laceration, and pulmonary embolism.

outcomes that we assessed (Table 3). These outcomes remained significant in the multivariate analysis. Low-risk women who received prenatal care from a midwife had a 13% lower risk of having their labor augmented (adjusted risk ratio [aRR], 0.87; 95% CI, 0.79-0.95), 33% lower risk of having their labor induced (aRR, 0.67; 95% CI, 0.59-0.76), and 31% lower risk of having epidural analgesia during labor (aRR, 0.69; 95% CI, 0.64-0.75) compared with similarly low-risk women who received prenatal care from a physician. We also found significant differences in maternal and neonatal outcomes. Women who received prenatal care from a midwife had a 34% lower risk of having a cesarean birth (aRR, 0.66; 95% CI, 0.57-0.78) and 42% lower risk of preterm birth (aRR, 0.58; 95% CI, 0.42-0.79) compared with similarly low-risk women who received prenatal care from a physician.

We found significant differences in rare interventions and outcomes as well. In the unadjusted models, women who received prenatal care from a midwife had lower odds of having an episiotomy and lower odds of having third- or fourth-degree lacerations, and had higher odds of postpartum hemorrhage compared with women who received prenatal care from a physician (Table 4). In the multivariate models, receiving prenatal care from a midwife remained significantly associated with reduced odds of having an episiotomy (adjusted odds ratio [aOR], 0.40; 95% CI, 0.24-0.65) and increased odds of postpartum hemorrhage (aOR, 3.26; 95% CI, 1.40-7.58). Women who received prenatal care from a midwife also had increased odds of shoulder dystocia (aOR, 1.80; 95% CI, 1.01-3.22). Prenatal care provider type was not significantly associated with increased odds of severe maternal morbidity,

**Table 2.** Birth Interventions, Maternal Outcomes, and Neonatal Outcomes of Women Who Initiated Prenatal Care Visits by 20 Weeks' Gestation and Gave Birth Between 2012 and 2015, by Initial Prenatal Care Provider Type (N = 8779)

| Birth Intervention or Outcome                        | Midwife (n = 721), n (%) | Physician (n = 8058), n (%) | P Value <sup>a,b</sup> |
|------------------------------------------------------|--------------------------|-----------------------------|------------------------|
| <b>Birth Intervention</b>                            |                          |                             |                        |
| <b>Labor induction</b>                               |                          |                             | <b>&lt;.0001</b>       |
| Yes                                                  | 181 (25.1)               | 2903 (36.0)                 |                        |
| No                                                   | 540 (74.9)               | 5155 (64.0)                 |                        |
| <b>Labor augmentation</b>                            |                          |                             | <b>.04</b>             |
| Yes                                                  | 299 (41.5)               | 3670 (45.5)                 |                        |
| No                                                   | 422 (58.5)               | 4388 (54.5)                 |                        |
| <b>Episiotomy</b>                                    |                          |                             | <b>.002</b>            |
| Yes                                                  | 16 (2.2)                 | 383 (4.8)                   |                        |
| No                                                   | 705 (97.8)               | 7675 (95.2)                 |                        |
| <b>Epidural analgesia</b>                            |                          |                             | <b>&lt;.0001</b>       |
| Yes                                                  | 360 (49.9)               | 5624 (69.8)                 |                        |
| No                                                   | 361 (50.1)               | 2434 (30.2)                 |                        |
| <b>Maternal Outcome</b>                              |                          |                             |                        |
| <b>Cesarean birth<sup>c</sup></b>                    |                          |                             | <b>&lt;.0001</b>       |
| Yes                                                  | 117 (16.3)               | 2416 (30.5)                 |                        |
| No                                                   | 602 (83.7)               | 5501 (69.5)                 |                        |
| <b>Third- and fourth-degree perineal lacerations</b> |                          |                             | <b>.31</b>             |
| Yes                                                  | 9 (1.3)                  | 150 (1.9)                   |                        |
| No                                                   | 712 (98.8)               | 7908 (98.1)                 |                        |
| <b>Postpartum hemorrhage</b>                         |                          |                             | <b>.038</b>            |
| Yes                                                  | 6 (0.8)                  | 25 (0.3)                    |                        |
| No                                                   | 715 (99.1)               | 8033 (99.7)                 |                        |
| <b>Shoulder dystocia</b>                             |                          |                             | <b>.16</b>             |
| Yes                                                  | 13 (1.8)                 | 96 (1.2)                    |                        |
| No                                                   | 708 (98.2)               | 7962 (98.8)                 |                        |
| <b>Severe maternal morbidity<sup>d</sup></b>         |                          |                             | <b>.39</b>             |
| Yes                                                  | 0 (0.0)                  | 18 (0.2)                    |                        |
| No                                                   | 721 (100.0)              | 8040 (99.8)                 |                        |
| <b>Neonatal Outcome</b>                              |                          |                             |                        |
| <b>Preterm birth</b>                                 |                          |                             | <b>&lt;.0001</b>       |
| Yes                                                  | 38 (5.3)                 | 922 (11.4)                  |                        |
| No                                                   | 683 (94.7)               | 7136 (88.6)                 |                        |
| <b>Stillbirth or neonatal death</b>                  |                          |                             | <b>.25</b>             |
| Yes                                                  | 0 (0.0)                  | 23 (0.3)                    |                        |
| No                                                   | 721 (100.0)              | 8035 (99.7)                 |                        |
| <b>5-minute Apgar &lt;7</b>                          |                          |                             | <b>.21</b>             |
| Yes                                                  | 12 (1.7)                 | 202 (2.5)                   |                        |
| No                                                   | 709 (98.3)               | 7856 (97.5)                 |                        |
| <b>Admission to level 3 or 4 NICU<sup>e</sup></b>    |                          |                             | <b>.08</b>             |
| Yes                                                  | 7 (2.4)                  | 275 (4.8)                   |                        |
| No                                                   | 281 (97.6)               | 5503 (95.2)                 |                        |

Abbreviation: NICU, neonatal intensive care unit.

<sup>a</sup> $\chi^2$  or Fisher's exact test as appropriate for categorical variables.

<sup>b</sup>Bold values indicate variables significant at the .05 level.

<sup>c</sup>Birth type missing for 143 women (n = 8636).

<sup>d</sup>Women were classified as having severe maternal morbidity if they experienced any of the following: acute renal failure, liver failure, respiratory failure, obstetric shock, cerebrovascular accident, pulmonary embolism, amniotic fluid embolism, eclampsia, septicemia, complications of anesthesia, or a cardiac event, and their length of stay for birth was more than 72 hours.

<sup>e</sup>NICU admissions available for 6066 births up to August 2014.

| <b>Table 3. Relative Risks of Common Birth Interventions and Outcomes,<sup>a</sup> Comparing Women Who Initially Saw a Midwife for Prenatal Care with Women Who Initially Saw a Physician for Prenatal Care, among Women Who Initiated Prenatal Care by 20 Weeks' Gestation and Gave Birth between 2012 and 2015 (N = 8779)</b> |                        |                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------------------|
| Birth Intervention or Outcome                                                                                                                                                                                                                                                                                                   | Bivariate Analysis     | Multivariate Analysis <sup>b</sup> |
|                                                                                                                                                                                                                                                                                                                                 | Unadjusted RR (95% CI) | Adjusted RR (95% CI)               |
| <b>Birth Intervention</b>                                                                                                                                                                                                                                                                                                       |                        |                                    |
| <b>Augmentation</b>                                                                                                                                                                                                                                                                                                             |                        |                                    |
| Yes                                                                                                                                                                                                                                                                                                                             | 0.91 (0.83-1.00)       | 0.87 (0.79-0.95)                   |
| No                                                                                                                                                                                                                                                                                                                              | 1                      |                                    |
| <b>Induction</b>                                                                                                                                                                                                                                                                                                                |                        |                                    |
| Yes                                                                                                                                                                                                                                                                                                                             | 0.70 (0.61-0.79)       | 0.67 (0.59-0.76)                   |
| No                                                                                                                                                                                                                                                                                                                              | 1                      | 1                                  |
| <b>Epidural analgesia</b>                                                                                                                                                                                                                                                                                                       |                        |                                    |
| Yes                                                                                                                                                                                                                                                                                                                             | 0.72 (0.66-0.77)       | 0.69 (0.64-0.75)                   |
| No                                                                                                                                                                                                                                                                                                                              | 1                      | 1                                  |
| <b>Maternal Outcome</b>                                                                                                                                                                                                                                                                                                         |                        |                                    |
| <b>Cesarean birth<sup>c</sup></b>                                                                                                                                                                                                                                                                                               |                        |                                    |
| Yes                                                                                                                                                                                                                                                                                                                             | 0.53 (0.45-0.63)       | 0.66 (0.57-0.78)                   |
| No                                                                                                                                                                                                                                                                                                                              | 1                      | 1                                  |
| <b>Neonatal Outcome</b>                                                                                                                                                                                                                                                                                                         |                        |                                    |
| <b>Preterm birth</b>                                                                                                                                                                                                                                                                                                            |                        |                                    |
| Yes                                                                                                                                                                                                                                                                                                                             | 0.46 (0.34-0.63)       | 0.58 (0.42-0.79)                   |
| No                                                                                                                                                                                                                                                                                                                              | 1                      |                                    |

Abbreviations: RR, relative risk; CI, confidence interval.

<sup>a</sup>Birth outcomes were considered to be common if they occurred in at least 5% of births.

<sup>b</sup>Model was adjusted for age, race, public insurance status, marital status, first birth, having previous pregnancy complications, having a previous cesarean birth, obesity, hypertension, and smoking during pregnancy.

<sup>c</sup>Birth type missing for 143 women (n = 8636).

admission to a level 3 or 4 NICU, low Apgar scores, or stillbirth and neonatal deaths in either the unadjusted or adjusted models.

The results of our propensity score analysis were similar to our original results for all outcomes of interest, with 2 exceptions (Tables 5 and 6; also see Supporting Information: Table S1). Using the propensity score, postpartum hemorrhage (odds ratio [OR], 0.67; 95% CI, 0.00-12.5) and shoulder dystocia (OR, 1.98; 95% CI, 0.97-3.89) were no longer significantly associated with prenatal care provider type.

## DISCUSSION

Two main concerns often surround studies on midwifery care. The first is that women self-select into midwifery care, and these women may be inherently different than women who choose physician care. The second issue is that women who remain in the care of a midwife will be less likely to experience complications requiring labor interventions and cesareans, because women who experience complications are likely to transfer to physician care during their pregnancy. Our study addressed both of these important concerns. Our study used an intent-to-treat approach to eliminate the effect of transfers of care on the study outcomes. In addition, the use of a propensity score analysis allowed us to account for the concern regarding women's self-selection. Our study is the first to assess the potential reduction of labor interventions

alongside the potential risk of increased adverse effects between women who received prenatal care from a midwife and women who received prenatal care from a physician and gave birth in the same US hospital. This approach allowed us to compare midwife and physician outcomes directly, without the need to account for institutional differences. This is particularly important when assessing cesarean birth rates, as these rates vary substantially across hospitals.<sup>26</sup> The variation in cesarean birth rates cannot be explained by hospital bed size, teaching status, geographic location, or clinical risk factors and therefore may largely stem from differences in institutional policies.<sup>26</sup> By comparing outcomes of births that occurred within a single hospital, we eliminated these external factors that could have lead to differences in labor interventions. However, having data from only one hospital may limit the generalizability of our findings.

In our study, a smaller proportion of women who received prenatal care from a midwife were black and had Medicaid insurance compared with women who received prenatal care from a physician. Women who received prenatal care from a midwife were also less likely to have a history of previous pregnancy complications or previous cesarean birth or to have experienced interventions during birth, including labor induction, augmentation, epidural analgesia, and episiotomy, compared with women who received prenatal care from a physician. In our intent-to-treat analysis, we found that the risk of having a cesarean and preterm birth were substantially

**Table 4.** Unadjusted and Adjusted Odds Ratios of Rare Birth Interventions and Outcomes,<sup>a</sup> Comparing Women Who Initially Saw a Midwife for Prenatal Care with Women Who Initially Saw a Physician for Prenatal Care, among Women Who Initiated Prenatal Care by 20 Weeks' Gestation and Gave Birth between 2012 and 2015 (N = 8779)

| Birth Intervention or Outcome                        | Bivariate Analysis     | Multivariate Analysis <sup>b</sup> |
|------------------------------------------------------|------------------------|------------------------------------|
|                                                      | Unadjusted OR (95% CI) | Adjusted OR (95% CI)               |
| <b>Birth Intervention</b>                            |                        |                                    |
| <b>Episiotomy</b>                                    |                        |                                    |
| Yes                                                  | 0.47 (0.28-0.77)       | 0.40 (0.24-0.65)                   |
| No                                                   | 1                      | 1                                  |
| <b>Maternal Outcome</b>                              |                        |                                    |
| <b>Third- and fourth-degree perineal lacerations</b> |                        |                                    |
| Yes                                                  | 0.70 (0.36-1.36)       | 0.58 (0.30-1.13)                   |
| No                                                   | 1                      | 1                                  |
| <b>Postpartum hemorrhage</b>                         |                        |                                    |
| Yes                                                  | 2.86 (1.21-6.80)       | 3.26 (1.40-7.58)                   |
| No                                                   | 1                      | 1                                  |
| <b>Shoulder dystocia</b>                             |                        |                                    |
| Yes                                                  | 1.57 (0.88-2.79)       | 1.80 (1.01-3.22)                   |
| No                                                   | 1                      | 1                                  |
| <b>Severe maternal morbidity</b>                     |                        |                                    |
| Yes                                                  | 0.30 (0.02-5.01)       | 0.50 (0.04-6.53)                   |
| No                                                   | 1                      | 1                                  |
| <b>Neonatal Outcome</b>                              |                        |                                    |
| <b>Admission to level 3 or 4 NICU<sup>c</sup></b>    |                        |                                    |
| Yes                                                  | 0.53 (0.26-1.11)       | 0.64 (0.31-1.35)                   |
| No                                                   | 1                      | 1                                  |
| <b>5-minute Apgar &lt;7</b>                          |                        |                                    |
| Yes                                                  | 0.68 (0.38-1.22)       | 0.85 (0.48-1.52)                   |
| No                                                   | 1                      | 1                                  |
| <b>Stillbirth or neonatal death</b>                  |                        |                                    |
| Yes                                                  | 0.24 (0.01-3.91)       | 0.32 (0.02-4.46)                   |
| No                                                   | 1                      | 1                                  |

Abbreviations: NICU, neonatal intensive care unit; OR, odds ratio (estimated using logistic regression with Firth's bias correction).

<sup>a</sup>Birth outcomes were considered to be rare if they occurred in less than 5% of births.

<sup>b</sup>Model was adjusted for age, race, public insurance status, marital status, first birth, having previous pregnancy complications, having a previous cesarean birth, obesity, hypertension, and smoking during pregnancy.

<sup>c</sup>NICU admissions available for 6066 births, up to August 2014.

lower among women who received prenatal care from a midwife, whereas there was no increase in the odds of adverse outcomes such as NICU admissions, low Apgar scores, or severe maternal morbidity. However, women who received prenatal care from a midwife had an increase in the odds of shoulder dystocia and postpartum hemorrhage.

Numerous studies have compared birth outcomes among women cared for by midwives and physicians, for prenatal care and birth, in countries where midwifery care is common. A recent Cochrane systematic review of 15 randomized controlled trials from Canada, the United Kingdom, Australia, and Ireland found that midwife-led care was associated with several benefits without evidence of adverse effects for women and infants compared with physician-led care.<sup>5</sup> The review found a significant reduction in epidural analgesia, episiotomies, and preterm births among women in midwife

care. However, the reviewers found no difference between the groups in the frequency of cesarean births, perineal lacerations requiring suturing, postpartum hemorrhage, or low Apgar scores. In addition, the United Kingdom's National Institute for Health and Care Excellence found that for low-risk women, those who gave birth in a midwife-led unit had lower rates of interventions, and that the infant outcomes were no different compared with women who gave birth in an obstetrician-led unit.<sup>6</sup> Our results support many of these findings. However, in contrast to the findings in the Cochrane review, we found a significant reduction in cesarean births and a significant increase in postpartum hemorrhage in women who received prenatal care from midwives. These disparities may be due to differences in the models of health care in the previously published studies. Only 3 of the studies included in the Cochrane review compared midwife-led care

**Table 5.** Relative Risks of Common Birth Interventions and Outcomes<sup>a</sup> and Outcomes of Propensity Score Analysis Comparing Women Who Initially Saw a Midwife for Prenatal Care with Women Who Initially Saw a Physician for Prenatal Care, among Women Who Initiated Prenatal Care by 20 Weeks' Gestation and Gave Birth between 2012 and 2015 (N = 8779)

| Birth Intervention or Outcome     | All Data                  |                                    | Propensity Score Matching     |
|-----------------------------------|---------------------------|------------------------------------|-------------------------------|
|                                   | Bivariate Analysis        | Multivariate Analysis <sup>b</sup> | Bivariate Analysis (n = 2884) |
|                                   | Unadjusted RR<br>(95% CI) | Adjusted RR<br>(95% CI)            | Unadjusted RR<br>(95% CI)     |
| <b>Birth Intervention</b>         |                           |                                    |                               |
| <b>Augmentation</b>               |                           |                                    |                               |
| Yes                               | 0.91 (0.83-1.00)          | 0.87 (0.79-0.95)                   | 0.83 (0.75-0.81)              |
| No                                | 1                         | 1                                  | 1                             |
| <b>Induction</b>                  |                           |                                    |                               |
| Yes                               | 0.70 (0.61-0.79)          | 0.67 (0.59-0.76)                   | 0.67 (0.59-0.77)              |
| No                                | 1                         | 1                                  | 1                             |
| <b>Epidural analgesia</b>         |                           |                                    |                               |
| Yes                               | 0.72 (0.66-0.77)          | 0.69 (0.64-0.75)                   | 0.68 (0.63-0.74)              |
| No                                | 1                         | 1                                  | 1                             |
| <b>Maternal Outcome</b>           |                           |                                    |                               |
| <b>Cesarean birth<sup>c</sup></b> |                           |                                    |                               |
| Yes                               | 0.53 (0.45-0.63)          | 0.66 (0.57-0.78)                   | 0.67 (0.57-0.80)              |
| No                                | 1                         | 1                                  | 1                             |
| <b>Neonatal Outcome</b>           |                           |                                    |                               |
| <b>Preterm birth</b>              |                           |                                    |                               |
| Yes                               | 0.46 (0.34-0.63)          | 0.58 (0.42-0.79)                   | 0.59 (0.42-0.83)              |
| No                                | 1                         |                                    | 1                             |

Abbreviation: RR, relative risk (estimated using Poisson regression).

<sup>a</sup>Birth outcomes were considered to be common if they occurred in at least 5% of births.

<sup>b</sup>Model was adjusted for: age, race, public insurance status, marital status, first birth, having previous pregnancy complications, having a previous cesarean birth, obesity, hypertension, and smoking during pregnancy.

<sup>c</sup>Birth type missing for 143 women.

with physician-led care. The additional studies included in the review compared midwife-led care with a shared model of care (ie, sharing of care between physicians and midwives to various degrees) or with various options of standard care, including shared and physician-led models. Midwife-led models of care, such as the model in our study, may be more beneficial in reducing cesarean births compared with the shared model of care. In addition, the scope of practice of midwives in the United States differs from that in the countries where these studies were performed. In some countries, such as Canada, the scope of practice for midwives is limited to the care of women with uncomplicated pregnancies, whereas in other countries, including the United Kingdom and Australia, midwives, in collaboration with obstetricians, provide care to women experiencing medical complications.<sup>5</sup> Our finding of a significant reduction in cesarean birth rates may only be applicable to a low-risk population, as was included in our study.

In the United States, midwifery care is less common than in other nations, with 8% of births attended by midwives,<sup>4</sup> and, perhaps as a result, fewer studies of midwifery care exist. A systematic review of studies performed in the United States found lower rates of cesarean births, fewer interventions during birth, and equally good maternal and neonatal outcomes among women who received care from midwives.<sup>16</sup> However,

the data from many of these studies were collected over 20 years ago. Much has changed in maternal health care during this time, the most striking of which has been a 60% increase in the overall cesarean birth rate, from 20.7% in 1996 to 32.9% in 2009.<sup>17</sup>

Few published studies have used data collected since 2000 to compare midwife-led prenatal care with physician-led care in the United States.<sup>10,14,15,27,28</sup> In a retrospective review of anal sphincter tears occurring among vaginal births at a single hospital in 2000 to 2004, investigators found a reduction in tears among women who used a midwife as a birth attendant compared with women who used a physician.<sup>14</sup> We found nonstatistically significant reduced odds of having third- or fourth-degree tears among women who received prenatal care from a midwife. Findings from the other studies were consistent with our results in that they found a reduction in use of labor interventions and in cesarean birth rates in the midwife group.<sup>10,15,27,28</sup> However, 2 of these studies compared physician-led care with a collaborative midwife-physician care model and did not directly compare midwife-led care with physician-led care as we did in our study.<sup>27,28</sup> In the study by Benatar et al, 30% of the midwife-attended births occurred in a stand-alone birth center rather than in a hospital.<sup>10</sup> As a result, the findings

**Table 6.** Unadjusted and Adjusted Odds Ratios of Rare Birth Interventions and Outcomes<sup>a</sup> and Outcomes of Propensity Score Analysis Comparing Women Who Initially Saw a Midwife for Prenatal Care with Women Who Initially Saw a Physician for Prenatal Care, among Women Who Initiated Prenatal Care by 20 Weeks' Gestation and Gave Birth between 2012 and 2015 (N = 8779)

| Birth Intervention or Outcome                        | All Data                  |                                    | Propensity Score Matching     |
|------------------------------------------------------|---------------------------|------------------------------------|-------------------------------|
|                                                      | Bivariate Analysis        | Multivariate Analysis <sup>b</sup> | Bivariate Analysis (n = 2884) |
|                                                      | Unadjusted OR<br>(95% CI) | Adjusted OR<br>(95% CI)            | Unadjusted OR<br>(95% CI)     |
| <b>Birth Intervention</b>                            |                           |                                    |                               |
| <b>Episiotomy</b>                                    |                           |                                    |                               |
| Yes                                                  | 0.47 (0.28-0.77)          | 0.40 (0.24-0.65)                   | 0.34 (0.19-0.57)              |
| No                                                   | 1                         | 1                                  | 1                             |
| <b>Maternal Outcome</b>                              |                           |                                    |                               |
| <b>Third- and fourth-degree perineal lacerations</b> |                           |                                    |                               |
| Yes                                                  | 0.70 (0.36-1.36)          | 0.58 (0.30-1.13)                   | 0.54 (0.25-1.03)              |
| No                                                   | 1                         | 1                                  | 1                             |
| <b>Postpartum hemorrhage</b>                         |                           |                                    |                               |
| Yes                                                  | 2.86 (1.21-6.80)          | 3.26 (1.40-7.58)                   | 0.67 (0.00-12.5)              |
| No                                                   | 1                         | 1                                  | 1                             |
| <b>Shoulder dystocia</b>                             |                           |                                    |                               |
| Yes                                                  | 1.57 (0.88-2.79)          | 1.80 (1.01-3.22)                   | 1.98 (0.97-3.89)              |
| No                                                   | 1                         | 1                                  | 1                             |
| <b>Severe maternal morbidity</b>                     |                           |                                    |                               |
| Yes                                                  | 0.30 (0.02-5.01)          | 0.50 (0.04-6.53)                   | 0.43 (0.00-4.42)              |
| No                                                   | 1                         | 1                                  | 1                             |
| <b>Neonatal Outcome</b>                              |                           |                                    |                               |
| <b>Admission to level 3 or 4 NICU</b>                |                           |                                    |                               |
| Yes                                                  | 0.53 (0.26-1.11)          | 0.64 (0.31-1.35)                   | 0.81 (0.30-1.95)              |
| No                                                   | 1                         | 1                                  | 1                             |
| <b>5-minute Apgar &lt;7</b>                          |                           |                                    |                               |
| Yes                                                  | 0.68 (0.38-1.22)          | 0.85 (0.48-1.52)                   | 0.93 (0.47-1.70)              |
| No                                                   | 1                         |                                    | 1                             |
| <b>Stillbirth or neonatal death</b>                  |                           |                                    |                               |
| Yes                                                  | 0.24 (0.01-3.91)          | 0.32 (0.02-4.48)                   | 0.43 (0.00-4.42)              |
| No                                                   | 1                         | 1                                  |                               |

Abbreviations: NICU, neonatal intensive care unit; OR, odds ratio.

<sup>a</sup>Birth outcomes were considered to be rare if they occurred in less than 5% of births.

<sup>b</sup>Model was adjusted for age, race, public insurance status, marital status, first birth, having previous pregnancy complications, having a previous cesarean birth, obesity, hypertension, and smoking during pregnancy.

do not directly compare outcomes of midwife-led care and physician-led care but rather compare aspects of midwife care and aspects of birth in a freestanding birth center with the care of physicians in a hospital. Our study directly compares birth outcomes of women who received prenatal care from a midwife and women who received prenatal care from a physician, as all births in our study occurred within the same facility.

Benatar et al also found a statistically significant reduction in the incidence of preterm birth among women who received prenatal care from a midwife,<sup>10</sup> which is consistent with our findings. Midwives spend more time on average with women during prenatal care visits, and a considerable part of this time is spent on counseling and education.<sup>1,29</sup> This

additional time focused on helping women make changes for a healthier pregnancy could perhaps explain part of the reduction we found in preterm births among women who received care from a midwife. However, a study using data collected from 1994 to 1996 that compared outcomes between women who received prenatal care from midwives and physicians did not find a significant reduction in preterm birth.<sup>11</sup>

The study by Jackson et al was the most recent that assessed shoulder dystocia and postpartum hemorrhage.<sup>11</sup> The study did not assess these variables directly but rather included them as part of an aggregate measure, and it did not find a significant difference in the aggregate measure of major intrapartum morbidity. Our study is the first to find an

increase in shoulder dystocia and postpartum hemorrhage among women who used a midwife for prenatal care, although we did not find this increase using the propensity score analysis. It is possible that some of the increase in shoulder dystocia cases in the midwife group was due to a larger proportion of women who were postdates in the midwife group compared with the physician group (48% of women in the midwife group were 40 weeks' gestation or more vs 27% in the physician group). The most substantial risk factor for shoulder dystocia is fetal macrosomia.<sup>30</sup> Given the significant increase in cesarean births among women who received prenatal care from a physician, it is probable that some women with large infants had cesarean births as well and thus their labor was not obstructed by shoulder dystocia. However, it is important to note that shoulder dystocia is considered an unpredictable and unpreventable event, and prophylactic cesarean births are not a recommended potential solution, as this would further increase cesarean birth rates without reducing the risk of shoulder dystocia.<sup>30</sup>

The measure of postpartum hemorrhage is determined by birth attendants, based on their estimate of the woman's blood loss, and is therefore highly subjective.<sup>31</sup> As a result, estimates of blood loss at birth are known to be inaccurate and are commonly underreported.<sup>32</sup> Perhaps midwives and physicians estimate blood loss differently because of differences in their training. The results of the propensity score matching, which found midwife care to be a nonsignificant protective factor for postpartum hemorrhage, may indicate that the results for such an uncommon outcome are unstable and cannot be decisively interpreted. Finally, although we observed a 3-fold increase in postpartum hemorrhage among women who received prenatal care from a midwife, the absolute risk for all women was low, with less than 1% of women in either group experiencing excessive bleeding. Unfortunately, we did not have information regarding the frequency of transfusions in the 2 groups. Both postpartum hemorrhage and shoulder dystocia were variables that we extracted from the electronic health record, and measurement error may have affected these results.

In a study of birth certificate data, neonatal outcomes of women who had home births attended by certified nurse-midwives were similar to those who had in-hospital physician births.<sup>7</sup> Our study similarly did not find an increase in neonatal deaths among births in the midwifery care group. However, although our study was powered to detect small differences in cesarean birth rates, as well as differences in infrequent outcomes, such as episiotomies, our study was not powered to detect small differences in extremely rare outcomes such as severe maternal morbidity and neonatal deaths, which occurred in only 0.2% to 0.3% of births. An additional limitation was the use of secondary data extracted from electronic health records. As these data were not collected for research purposes, health care providers might have failed to document every labor intervention appropriately.

Finally, as this was an observational study and not a randomized trial, unmeasured confounding could have remained after adjustment. Given the magnitude of the effect that we found in regard to cesarean birth rates, the residual confounding would need to be substantial to account for the difference found.

## CONCLUSION

One in 3 women in the United States has a cesarean birth. Our study provides further evidence that midwives provide a safe alternative to physician prenatal care and that midwifery care may lead to a lower cesarean birth rate. Future research is needed to evaluate the effect that midwifery care can have among diverse populations. Integrating independent midwifery practices into additional maternity care hospitals will allow more women to enjoy the positive effect associated with care led by certified nurse-midwives. Further research is necessary to assess whether the same effects are found in different models of midwifery care to understand the best way to incorporate midwifery care more routinely into the US health care system.

## AUTHORS

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## CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

## SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's website:

**Table S1.** Sociodemographic and Health Characteristics of Women Who Initiated Prenatal Care Visits by 20 Weeks' Gestation, by Initial Prenatal Care Provider Type for All Women (N = 8779) and after Propensity Score Matching

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