Received: 26 May 2017 | Revised: 18 October 2017 | Accepted: 18 October 2017

DOI: 10.1111/birt.12322

ORIGINAL ARTICLE

WILEY BIRTH ISSUES IN PERINATAL CARE

Rural community birth: Maternal and neonatal outcomes for planned community births among rural women in the United States, 2004-2009

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Abstract

Background: Approximately 22% of women in the United States live in rural areas with limited access to obstetric care. Despite declines in hospital-based obstetric services in many rural communities, midwifery care at home and in free standing birth centers is available in many rural communities. This study examines maternal and neonatal outcomes among planned home and birth center births attended by midwives, comparing outcomes for rural and nonrural women.

Methods: Using the Midwives Alliance of North America Statistics Project 2.0 dataset of 18 723 low-risk, planned home, and birth center births, rural women (n = 3737) were compared to nonrural women. Maternal outcomes included mode of delivery (cesarean and instrumental delivery), blood transfusions, severe events, perineal lacerations, or transfer to hospital and a composite (any of the above). The primary neonatal outcome was a composite of early neonatal intensive care unit or hospital admissions (longer than 1 day), and intrapartum or neonatal deaths. Analysis involved multivariable logistic regression, controlling for sociodemographics, antepartum, and intrapartum risk factors.

Results: Rural women had different risk profiles relative to nonrural women and reduced risk of adverse maternal and neonatal outcomes in bivariable analyses. However, after adjusting for risk factors and confounders, there were no significant differences for a composite of maternal (adjusted odds ratio [aOR] 1.05 [95% confidence interval {CI} 0.93-1.19]) or neonatal (aOR 1.13 [95% CI 0.87-1.46]) outcomes between rural and nonrural pregnancies.

Conclusion: Among this sample of low-risk women who planned midwife-led community births, no increased risk was detected by rural vs nonrural status.

KEYWORDS

access to care, birth center, health policy, home birth, midwifery, rural health

1 | INTRODUCTION

Pregnant women face many challenges in accessing maternity care services in rural and remote areas of the United States. These include: obstetric unit closures in rural hospitals,[1] shortages of qualified childbirth providers in rural areas,[2,3] and distances to travel to access care.[4] Currently, over 80% of rural counties have no hospital providing obstetric services[1,5] and 50% of rural counties have no actively practicing obstetric physicians.[2]

Difficulty accessing prenatal care[6] and long travel times to a hospital during labor have been linked to higher rates of adverse neonatal outcomes[7] and high psychosocial costs.[8,9] In contrast, receiving care and giving birth closer to home have demonstrated benefits;[10,11] however, with the declining availability of care in rural settings, this ideal is increasingly difficult to achieve. Although the majority of United States women deliver in hospitals with physicians, an increasing number of women are choosing a midwife as their care provider and planning to deliver at home or in a free standing birth center.[12] Independent midwives (not employed by a hospital) and who provide delivery services in the community setting (ie, home or a freestanding birth center) are referred to as "community midwives" and can include Certified Professional Midwives (CPMs), Certified Nurse Midwives (CNMs), Certified Midwives, state-licensed Licensed Midwives, or lay midwives.[13] A growing body of evidence suggests that for healthy women who meet criteria for a low-risk delivery, community birth is a safe option when assisted by well-trained and licensed/certified midwives.[14,15] However, definitions of "low risk" vary.[16] Noting the increased demand for midwifery care and community birth, the American College of Obstetricians and Gynecologists (ACOG) released a new position statement on home birth[17] which defines criteria, similar to those used by midwifery professional organizations in other countries, for promoting favorable birth outcomes among women planning a community birth.

ACOG, in their 2014 statement on rural health disparities, also notes that: "less than one half of rural [US] women live within a 30-minute drive to the nearest hospital offering perinatal services."[18] For some rural women, a midwife-attended home birth may align with core cultural or religious beliefs,[19,20] while allowing them to avoid having to travel to another community for birth.[21] Despite the challenges of rural maternity practice, 22% of CNMs,[22] at least 33% of CPMs,[13] and an unknown number of other midwives practice in rural areas. In 2006, the percentage of home births to women living in rural counties was 74% higher as compared to nonrural counties;[23] a similar trend has been observed in Canada.[24] Because rural community birth can be complicated by delays in accessing emergency backup services when intrapartum or postpartum complications arise, it is not immediately clear that midwife-led birth in community settings is a viable solution to address limited rural access to maternity care.

Only two United States studies have examined midwife-led care among rural women, both with good outcomes;[25,26] however, these studies were limited to small local areas. In Canada and New Zealand, midwife-led care for rural women has been shown to result in excellent outcomes[24,27,28] even in extremely remote[29] communities without local cesarean backup. However, the United States' health care system differs from these other countries in having a mixed public-private health care system and a high rate of uninsured or underinsured individuals; thus, findings reported elsewhere may not be generalizable to the United States. There is no existing national level research on perinatal outcomes for rural women who planned home or birth center births with community midwives in the United States. Thus, the purpose of this study was twofold. Using data collected through the Midwives Alliance of North America (MANA) Statistics Project,[30,31] we aimed to (1) describe rates for mode of delivery and other maternal and neonatal outcomes among rural women with low-risk pregnancies who planned a community birth with a midwife; and (2) to compare rates of modes of delivery and adverse outcomes among rural vs nonrural women.

2 | METHODS

The MANA Statistics Project (MANA Stats) was initiated in early 2000 to collect data on midwife-led courses of care and outcomes from planned home and birth center births. This study uses the MANA Stats 2.0 dataset (2004-2009), which includes data from medical records, logged prospectively by midwives, beginning at the initiation of care before the outcomes of the pregnancy are known. Over 200 variables were collected, including demographics; maternal residential zip code; reproductive, health, and social histories; antepartum, intrapartum, postpartum (maternal), and neonatal outcomes; as well as procedures or actions during these phases. Intended and actual place of birth was also recorded. Midwifery participation was voluntary and approximately 20-30% of active CPMs and a smaller proportion of active CNMs/CMs participated across the United States. Details of the outcomes from the main cohort (N = 24 848) have been published previously,[31] as have details of the data validation process.[30] The analysis plan for this study was reviewed and approved by the Institutional Research and Ethics Boards at Bastyr University and by the Institutional Review Board at Oregon State University; women provided written informed consent for their data to be included in the MANA Stats research dataset.

For this analysis, exclusions from the MANA Stats 2.0 dataset (N = 24 848)[16] are shown in Figure 1. After limiting to pregnancies with valid rural or nonrural zip codes, those with more complicated pregnancies—multifetal pregnancies (n = 66), breech singleton presentations (n = 236), known congenital anomalies (n = 30), preexisting maternal conditions (chronic anemia not resolved, chronic hypertension, eclampsia, preeclampsia, Rh sensitization, gestational diabetes) (n = 511), or prior cesarean delivery (n = 1124)—were also excluded. The final sample for these analyses consisted of 18 723 low-risk, mother-infant dyads planning community births at the onset of labor. All women who planned a midwife-attended birth at home or in a birth

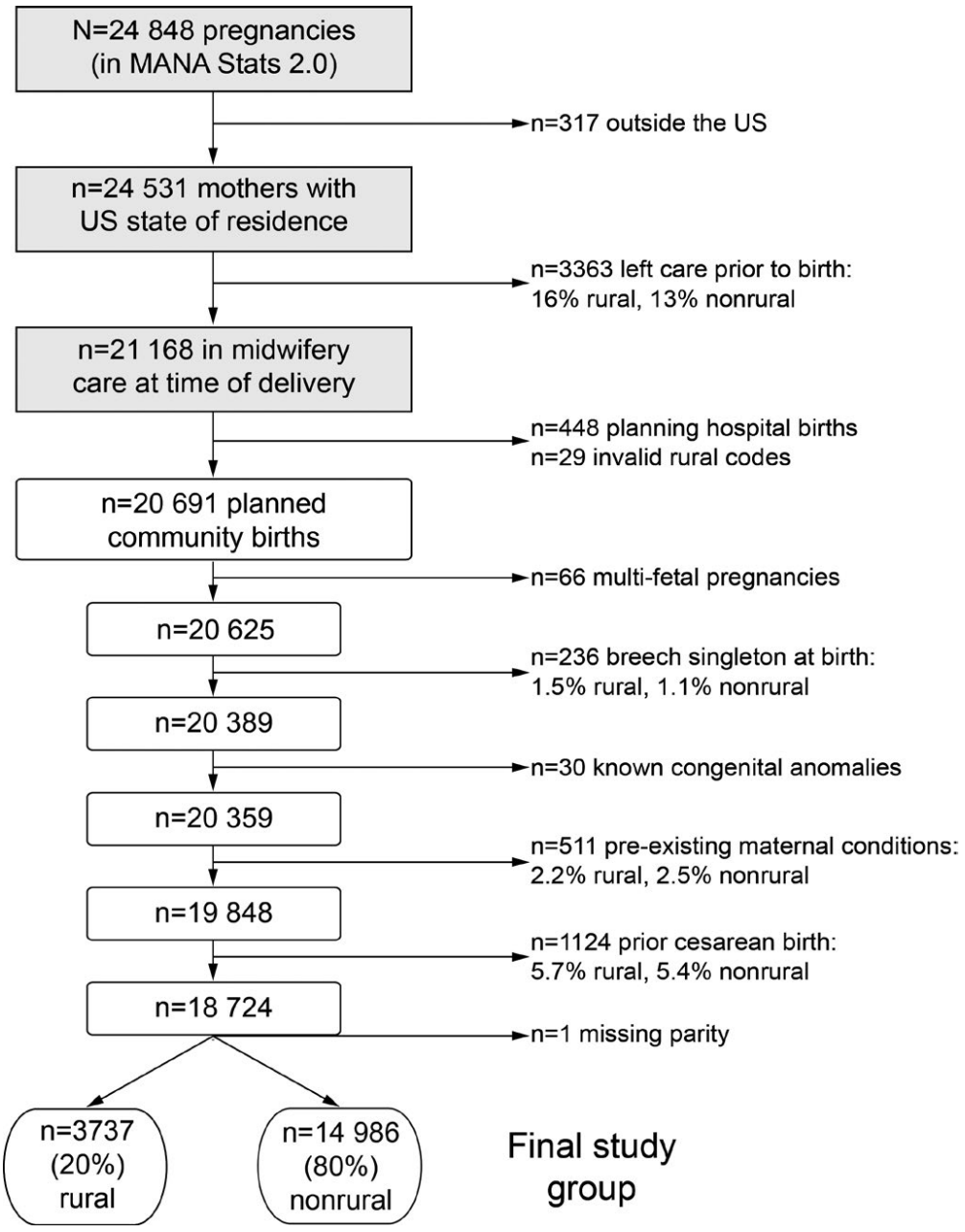

FIGURE 1 Derivation of low-risk cohort (N = 18 724) of rural and nonrural women who planned community births, MANA Stats 2.0, 2004-2009

center at the initiation of labor were included in the study even if transfer to a hospital and/or physician care occurred during labor or in the postpartum period. Based on a study population of 18 000 births and 3400 in the rural cohort, this analysis had 80% power to detect an odds ratio (OR) of 1.15 (or 0.87) at a 95% confidence level (CI) for most outcomes.[32] The detectable OR was 1.4 (0.71) if the outcome occurred less than 1% of the time in the rural group. The mother's home zip code was matched to the U.S. Census Bureau's Rural-Urban Commuting Area (RUCA) codes (version 2.0)[33]—a coding scheme that uses geographic area data and commuting patterns to characterize census tracts. RUCA codes have been used previously in birth outcomes research studies.[34,35] Rural residential zip codes were identified for this study, using RUCA codes following an approach used by the Federal Office of Rural Health Policy.[36] RUCA codes range from 1 to 10, corresponding with larger to smaller population areas, respectively. For this study, RUCA codes of 4 or greater and RUCA codes 2 or 3 with zip code areas at least 200 square miles in size or a population density of no more than 20 individuals per square mile were considered "rural."

Outcome measures that indicated a need for higher-level obstetric care, which might be adversely affected by distance

and/or travel time, were the focus of this analysis. Maternal outcomes included cesarean delivery, assisted delivery (forceps or vacuum), intrapartum transfer, postpartum (maternal indication) transfer, any severe events (seizure, eclampsia, uterine rupture, cord prolapse, embolism), maternal blood transfusion, and third or fourth degree perineal laceration or cervical trauma. A "maternal composite" was created which included any of the events listed above.

Neonatal outcomes included 5-minute Apgar scores <7 and <4, assisted ventilation for longer than 10 minutes, congenital anomalies, and any hospital or neonatal intensive care unit (NICU) admission (in the first 48 hours) lasting longer than 24 hours. A "neonatal composite" included hospital or NICU admission in the first 48 hours, 5-minute Apgar less than 4, or intrapartum or early neonatal death (in the first 7 days). Intrapartum or early neonatal deaths were not considered individually due to low numbers. Late neonatal deaths were not included as the intention was to focus on intrapartum-related morbidities, which might be affected by rural status. Deaths linked to severe congenital anomalies not compatible with life were excluded (n = 8). Hospital admissions were combined with early NICU admissions to minimize bias, since many rural hospitals do not have NICUs.

To maximize statistical power in this cohort with known low rates of adverse outcomes,[31] the maternal and neonatal composites were considered the primary outcomes for analysis, with secondary analyses focused on the individual measures (mode of delivery, adverse maternal and neonatal outcomes). Two alternate definitions were generated for the "maternal composite" variable: first, excluding all transfers and second, excluding transfers for nonurgent reasons (ex. slow progress or pain relief).

2.1 | Analysis

All outcomes were examined for association with rural residence first using univariate methods (chi-squared test or ANOVA), followed by multivariable logistic regression modeling to control for potential confounding. Univariate logistic regression models were created for the two primary outcomes first, with rural status alone as the predictor to estimate unadjusted ORs. Potential confounders considered in multivariable logistic models (in addition to rural residence) were as follows: maternal age (continuous); maternal prepregnancy body mass index (BMI) (continuous); maternal education (3 categories: up to high school, up to 4 years postsecondary or undergraduate degree, more than 4 years postsecondary); race/ethnicity (white vs all others); Amish, Mennonite, or Plain status; maternal insurance status (Medicaid vs private); parity (nulliparous vs multiparous vs >4 parity); reported prenatal medical conditions (pregnancy-induced hypertension or any infection); any prenatal testing (ultrasound, routine testing); and gestational age of infant (for neonatal outcomes only).

All potential predictors that were either significant in univariate models or those that are known risk factors (race/ethnicity, age, BMI, payer status)[16,21,37] were considered in multivariable models. All variables were offered to the multiple regression model in a manual backwards stepwise approach; final models were those with the lowest Akaike Information Criterion and significant predictors ($P < .01$). Two stable sets of predictors were identified for the maternal and neonatal composites, respectively. All primary and secondary outcomes were then adjusted, a priori, for the same set of predictors (listed in Tables 2 and 3) in addition to rural residence. Results are presented as an unadjusted and adjusted OR where nonrural (other) residence is the reference group. A complete case analysis approach was used: any records missing data were excluded from regression models; overall, n = 311 pregnancies and n = 44 neonates were excluded based on missing covariates. All analyses were conducted using SAS v9.3 (SAS Institute, Cary, NC, USA). Cases that resulted in an intrapartum transfer were removed from models for postpartum transfer, and cesarean deliveries were removed from models for severe perineal lacerations as these were no longer at risk.

Three additional sets of sensitivity analyses were also carried out. First, all models were rerun excluding women belonging to a Mennonite, Amish, or Plain church (4.1% of the total sample, 21% of the rural group), because these communities are known to have specific birth characteristics (low rates of interventions, high rates of home birth, high rates of congenital anomalies, and low rates of transfer for pain relief).[25] Second, all models were stratified by parity and, third, by planned birth location (home vs birth center).

3 | RESULTS

The rural group (Table 1) was primarily white (92%) and most ethnic groups were underrepresented compared to the general childbearing population, which reflects the United States demographics of predominantly white women choosing a midwife-led community birth.[38] Latina women were proportionally equivalent in both groups. Rural women had lower levels of educational attainment, were slightly younger, had higher initial BMIs, and higher rates of expected payment method listed as Medicaid insurance compared to nonrural women. A large proportion (20.8%) of the rural group belonged to the Amish, Mennonite, or Plain church. There were no differences in marital status, but all other demographics were significantly different ($P < .001$). Rural women were more likely to be multiparous, to have had a previous home or birth center birth, and to be "grand multiparas" (>4 previous pregnancies lasting

TABLE 1 Characteristics of rural and nonrural women who planned community births, MANA Stats 2.0, 2004-2009

Characteristic	Rural residence (n = 3737) Median [IQR] or No. (%)	Nonrural (n = 14 986) Median [IQR] or No. (%)
Race/ethnicity[a]		
African or Caribbean	18 (0.5)	140 (0.9)
Asian	9 (0.2)	133 (0.9)
Caucasian	3422 (91.6)	13 266 (88.5)
Hispanic or Latina	67 (1.8)	248 (1.7)
Native American	18 (0.5)	20 (0.1)
Other	25 (0.7)	124 (0.8)
More than one race indicated	167 (4.5)	914 (6.1)
Education[a]		
Any high school or completed	1832 (49.0)	3868 (25.8)
Any postsecondary up to 4 years	1429 (38.2)	7607 (50.8)
More than 4 years of postsecondary	417 (11.2)	3187 (21.3)
Belongs to Amish, Mennonite, or other Plain church[a]	777 (20.8)	258 (1.7)
Any Medicaid, primary or secondary[a]	499 (13.4)	1635 (10.9)
Any other insurance (non-Medicaid), primary or secondary[a]	745 (19.9)	6408 (42.8)
Marital status: married, partnered, or common-law	3643 (97.5)	14 558 (97.1)
Age[a]	29 [25-33]	30 [26-33]
BMI at beginning of pregnancy[a]	22.8 [21-26]	22.5 [21-25]
Nulliparous[a]	1182 (31.6)	5801 (38.7)
Grand multiparity (>4 prior vaginal deliveries)[a]	446 (11.9)	611 (4.1)
History of home or birth center birth[a]	1858 (49.7)	5596 (39.8)
Planned birth location at onset of labor[a]		
Freestanding birth center	620 (16.6)	2910 (19.4)
Home	3117 (83.4)	12 076 (80.6)
Number of prenatal care visits with this midwife[a]	10 [7-12]	11 [9-12]
Weeks (from last menstrual period) that any prenatal care began[a]	12 [9-16]	11 [8-13]

[a]$P \leq .001$. Categorical variables: Chi-squared or Fisher's exact tests; continuous variables: Kruskal-Wallis test.

20 weeks or more). While both groups initiated prenatal care early, on average, rural women initiated care 1 week later and had fewer prenatal visits (median 10 vs 11). Rural women had fewer ultrasounds and other prenatal testing.

Regarding intrapartum and maternal events (Table 2), the nonrural group had higher rates of intrapartum and postpartum transfer, and cesarean delivery. Unadjusted models for adverse maternal outcomes showed overall *decreased* risk of adverse outcomes for rural women. However, after adjusting for other risk factors and confounders, these associations were attenuated. For the primary maternal composite, rural status was not associated with an increased risk (adjusted OR [aOR] 1.05 [95% confidence interval {CI} 0.93-1.19]) relative to nonrural women. Results were generally unchanged (data not shown) for alternate maternal composites that excluded transfers.

However, stratifying by parity resulted in a modest, yet statistically significant increase in risk for the maternal composite only among the rural multiparous group (aOR 1.27 [95% CI 1.03-1.55] vs aOR 0.97 [95% CI 0.83-1.21] for rural nulliparous women) (Figure 2). Similar results were not observed for noncomposite indicators: mode of delivery, transfers, or other adverse outcomes.

Rates of adverse neonatal events are shown in Table 3. There were more postterm deliveries in the rural group, and rural infants had significantly higher rates of small for gestational age. We did not detect any increased risk by rural status relative to nonrural status, for any of the primary neonatal events in both unadjusted and adjusted models. All analyses were repeated excluding the Amish, Mennonite, and Plain women and stratified by planned home and birth center birth with no change in the main results (data not shown).

4 | DISCUSSION

This is the first study to describe birth outcomes from rural midwifery clients who met criteria for low-risk birth[17] and who planned to give birth at home or in freestanding birth centers in the United States. Overall, despite the challenges of rural practice and the differential risk profile of rural women, this analysis found no increased risk of adverse maternal outcomes among rural women when compared to nonrural women who also planned community births.

Absolute risks of cesarean delivery, or adverse maternal and neonatal outcomes among all women in this low-risk group, were extremely low and comparable to other studies of community birth,[15,39] despite the fact that the United States maternity care system is not generally considered well-integrated with respect to community midwifery practice.[40] For example, the rate of cesarean delivery in the present study (which excluded women with prior cesarean births, breeches, twins, preexisting medical conditions, or a gestational diabetes diagnosis) was 4.7% overall (<1% in multiparous women, 11% in nulliparous women) and not elevated by rural status. By comparison, a recent analysis found a 15.5% cesarean rate among low-risk women delivering at rural hospitals in the United States.[37] These differences in cesarean rates may reflect differences in criteria for low risk when comparing to hospital cohorts, differences in the midwifery model of care (ie, promoting physiologic birth), or inherent differences in women who seek out midwifery care with respect to motivation to achieve an unmedicated or vaginal delivery. Rates of adverse neonatal outcomes are difficult to compare across studies due to inconsistencies in metrics and whether or not severe congenital anomalies are included in the study group. Rates of adverse neonatal outcomes in this cohort were generally similar to other studies of planned home births.[14,39]

Similar to results reported elsewhere, rural women in this study were younger,[37] more likely to have Medicaid for payment,[37] less diverse,[37] and more likely to initiate care later in pregnancy.[35] They had lower rates of antenatal complications,[37] fewer years of formal education, fewer antenatal visits,[41,42] and were more likely to be planning a home birth versus a birth center birth.[24,43] Rural women in our study were also more likely to be multiparous and have higher parity relative to the rest of the cohort, even excluding the Plain subgroup. Before adjusting for risk factors, rural women demonstrated a *decreased* risk for

TABLE 2 Unadjusted and adjusted odds ratios for rural and nonrural women who planned community births, MANA Stats 2.0, 2004-2009

Intrapartum, delivery, and postpartum outcomes	Rural residence (n = 3737) No. (%)	Nonrural (n = 14 986) No. (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[a]
Birth location (actual)[b]				
Freestanding birth center	520 (13.9)	2394 (16.0)		
Home	2881 (77.1)	10 819 (72.2)		
Hospital	327 (8.8)	1751 (11.7)		
Other	9 (0.2)	21 (0.1)		
Waterbirth[b]	1021 (27.3)	4926 (32.9)		
Mode of delivery				
Normal spontaneous vaginal delivery[b]	3564 (95.4)	14 080 (94.0)		
Instrumental delivery only (forceps or vacuum)	33 (0.9)	162 (1.1)	0.80 (0.54-1.15)	0.99 (0.65-1.46)
Cesarean delivery[b]	140 (3.7)	738 (4.9)	**0.76 (0.63-0.91)**[f]	1.06 (0.87-1.29)
Severe events (abruption, embolism, ruptured uterus, cord prolapse, seizure)	20 (0.5)	76 (0.5)	1.06 (0.63-1.71)	1.01 (0.58-1.69)
Blood transfusion (as reported by midwife)	15 (0.4)	51 (0.3)	1.17 (0.64-2.03)	1.38 (0.73-2.44)
Third or fourth degree perineal tear[c]	35 (1.0)	196 (1.4)	**0.70 (0.48-0.99)**	0.95 (0.65-1.36)
Intrapartum transfer to higher level of care[b]	333 (8.9)	1767 (11.8)	**0.74 (0.65-0.83)**	1.00 (0.87-1.15)
Postpartum transfer to higher level of care[d]	64 (1.9)	276 (2.1)	0.90 (0.68-1.17)	1.06 (0.79-1.40)
Maternal composite[b,e]	441 (11.8)	2188 (14.6)	**0.79 (0.71-0.88)**	1.05 (0.93-1.19)

[a]All models adjusted for: rural status, maternal age (continuous), BMI (continuous), parity (no prior births vs <5 births vs ≥5 births), belonging to Amish, Mennonite, or other Plain church (y/n).

[b]$P \leq .001$. Categorical variables: Chi-squared or Fisher's exact tests.

[c]Cesarean births excluded from the denominator as these cases are no longer at risk for severe perineal lacerations.

[d]Intrapartum transfers excluded from the denominator as these cases are no longer at risk for postpartum transfer.

[e]Maternal composite defined as: any of cesarean delivery, instrumental delivery, severe events, blood transfusions, third or fourth degree perineal laceration, intrapartum or postpartum transfer.

[f]Bolded ORs are statistically significant (greater or less than 1).

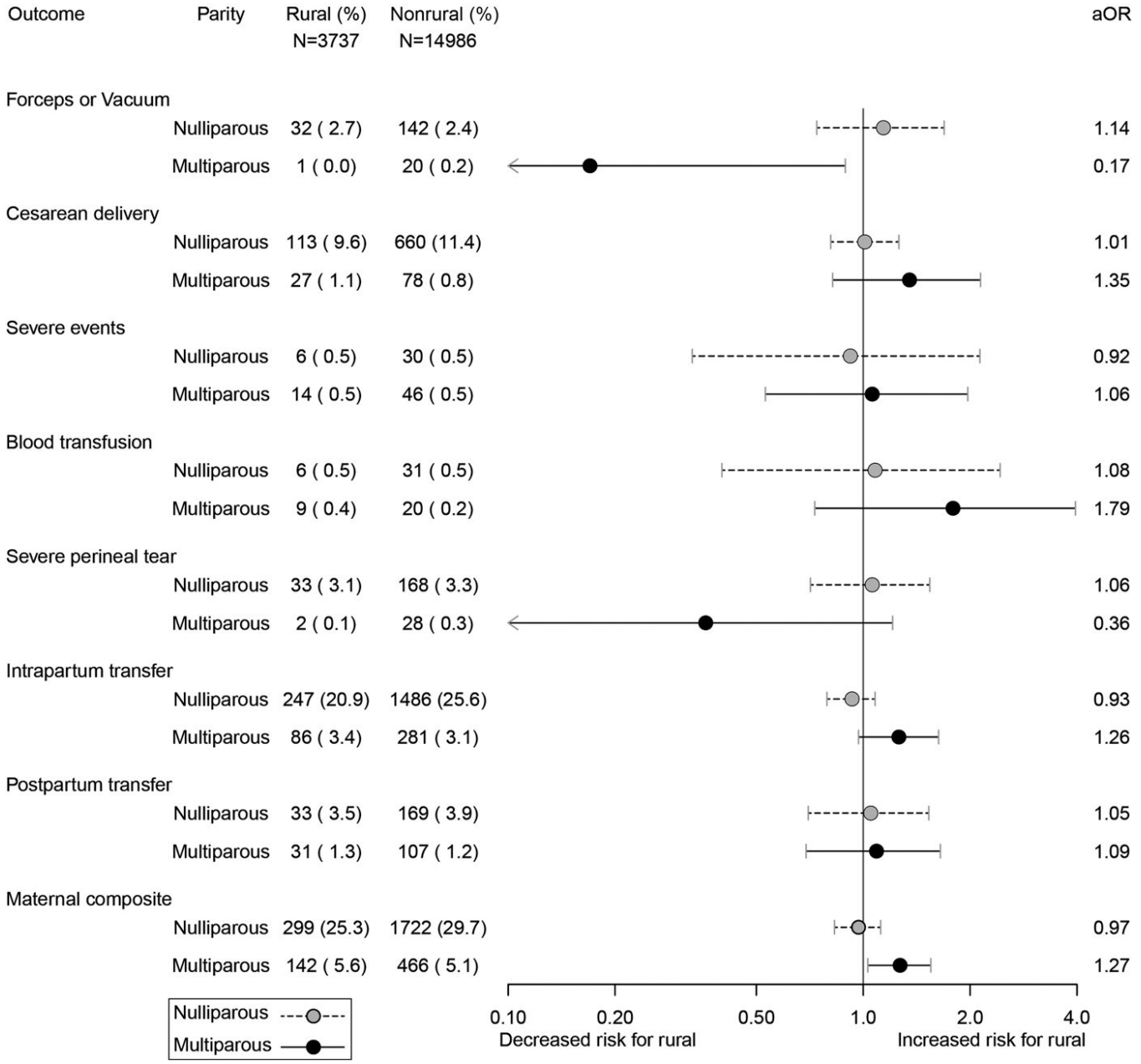

FIGURE 2 Adjusted odds ratios by parity, for rural and nonrural women who planned community births, MANA Stats 2.0, 2004-2009

most adverse outcomes; however, after adjusting for risk factors (listed in Tables 2 and 3), rural status was not associated with an increased risk for women or infants.

When stratifying by parity, there was a slightly increased risk for rural multiparous women when compared to nonrural multiparas with regard to the maternal composite variable only. This finding was unanticipated as multiparous women are usually considered a low-risk group. This finding has not been previously reported and because rates of complications among multiparas are generally low, the significance of these findings is unclear. Further, we cannot discount the possibility of a type 1 error (ie, that this is a chance finding).

An increased risk of adverse events in the rural group was expected in this study as we anticipated that longer transfer times to the hospital from home or birth center would result in a higher rate of poor outcomes in that group. Transfer times vary based on actual distance to the nearest hospital with obstetrics, mode of travel (air, car, ambulance, etc.), weather considerations, availability of ambulance or other transports, or delays because of low levels of interprofessional collaboration.[40,44] There are several possibilities as to why this was not the case in this analysis. First, midwifery care in both rural and nonrural settings involves risk screening and transferring clients as indicated in the antepartum, intrapartum, or postpartum periods. Midwives in this study may have been referring earlier and more conservatively with rural clients, as has been reported in other jurisdictions.[45] Second, the rural cohort may have a different

TABLE 3 Unadjusted and adjusted odds ratios for neonatal outcomes among rural and nonrural women who planned community births, MANA Stats 2.0, 2004-2009

Neonatal outcomes	Rural residence (n = 3737) Median [IQR] or No. (%)	Nonrural (n = 14 986) Median [IQR] or No. (%)	Unadjusted OR (95% CI)[a]	Adjusted OR (95% CI) [b]
Gestational age	281 [275-287]	281 [275-287]		
Preterm (<37 completed weeks)	72 (1.9)	242 (1.6)		
Postterm (>42 completed weeks)[c]	332 (8.9)	1039 (6.9)		
Small for gestational age (SGA)[c,d]	177 (4.7)	524 (3.5)		
Large for gestational age (LGA)[d]	653 (17.5)	2790 (18.6)		
Low birthweight (<2500 g)	35 (0.9)	101 (0.7)		
Macrosomic (>4000 g)	804 (21.5)	3266 (21.8)		
Macrosomic (>4500 g)	162 (4.3)	663 (4.4)		
Neonatal adverse outcomes				
5-min APGAR <7	54 (1.4)	193 (1.3)	1.16 (0.85-1.56)	1.33 (0.96-1.82)
5-min APGAR <4	20 (0.5)	67 (0.4)	1.23 (0.72-1.99)	1.43 (0.83-2.37)
Assisted ventilation >10 min	20 (0.5)	84 (0.6)	1.01 (0.60-1.62)	1.16 (0.67-1.90)
Congenital anomaly	64 (1.7)	236 (1.6)	1.07 (0.80-1.41)	1.02 (0.75-1.38)
Any NICU stay in the first 6 weeks[e]	77 (2.1)	450 (3.0)	**0.69 (0.53-0.87)**[g]	0.84 (0.65-1.08)
Hospital or NICU stay in the 1st 48 h for longer than 24 h	66 (1.8)	314 (2.1)	0.85 (0.64-1.10)	1.07 (0.80-1.40)
Neonatal composite[f]	78 (2.1)	353 (2.4)	0.89 (0.69-1.13)	1.13 (0.87-1.46)

[a]Logistic regression models use rural residence as the exposure of interest.
[b]Models are adjusted for: maternal age (continuous), BMI (continuous), parity (no prior births vs <5 births vs ≥5 births), belonging to Amish, Mennonite or other Plain church (y/n), gestational age at delivery (continuous) in addition to rural status.
[c]$P \leq .001$. Categorical variables: Chi-squared or Fisher's exact tests; continuous variables: Kruskal-Wallis test.
[d]Small for gestational age (SGA) defined as <10th percentile for gestational age and large for gestational age (LGA) as >90th percentile for gestational age using gender-specific birthweight data from the 1999-2000 U.S. Natality Datasets (by week of completed gestation).
[e]$P \leq .01$; same methods.
[f]Neonatal composite defined as: Any NICU admission or hospital (1st 48 h, >24 h), 5-minute Apgar <4 or intrapartum or neonatal deaths.
[g]Bolded ORs are statistically significant.

risk profile beyond the factors for which we controlled in this analysis (listed in Tables 2 and 3). Third, practitioners who serve rural clients may be different in terms of training, experience, or regulatory status. Others have reported high clinician variability in assessment of decision to transfer from home or birth centers.[46] Fourth, rates of adverse events were low overall; studies with a larger cohort may be necessary to detect any significant differences. However, our point estimates were not consistent with poorer outcomes for rural women and thus increasing the sample size would not necessarily alter our conclusions.

In a recent survey of hospital administrators, Kozhimannil and colleagues found that restrictive practice conditions for nurse-midwives were associated with a higher odds of cesarean delivery, preterm birth, and low birthweight infants,[47] suggesting that policies that facilitate access to midwifery care may help to improve outcomes. The findings reported here add further support to such a strategy. With the diminishing numbers of maternity care providers in rural settings, rural midwives may be well positioned to offer in-home antenatal, postpartum, and well baby care, as well as lactation support and community birth for low-risk women.

4.1 | Strengths and limitations

This analysis reports on a low-risk subset of pregnancies from the MANA Statistics Project from 2004 to 2009. The strengths of this dataset are a large sample size, a rigorously validated data collection tool, an extremely high participation rate among women (99.2% of eligible women gave consent for their data to be included in the research dataset),[48] a large number of covariates, and a prospective data collection strategy whereby clients are preregistered into the system early in care.[30] No prior analyses have examined rural status and birth outcomes within a cohort of women who planned midwife-attended births at home or in freestanding birth centers. Despite these strengths, contributing data to the MANA Statistics Project is voluntary for midwives and represents

outcomes of care for approximately 30% of United States community-based midwives practicing at that time; there is no way to predict how voluntary sampling may have affected our findings. Midwifery practice conditions and standards of care across the United States are highly variable due to state-specific regulation, legislative conditions, and licensure (or the absence thereof). More recent MANA stats data were not available for research when the study was initiated; however, future studies could incorporate newer data, as data through 2016 are now available. This study relied on maternal zip code to estimate rural status—an approach that is more precise than using county-level indicators, but that may not accurately reflect actual transfer times in case of emergency in all regions. Finally, this study was limited by inadequate power to study rare outcomes, despite using a neonatal composite to increase statistical power. While we did not detect any differences in neonatal outcomes by rural status, replication with a larger study sample could indicate significant clinical differences between midwife-attended rural and nonrural women in the United States which were too small to detect in our study.

4.2 | Conclusions

This is the first study to describe maternal and neonatal outcomes for midwife-led care among a cohort of low-risk rural and nonrural women who planned midwife-attended, community births in the United States. Healthy, low-risk, rural women planning home or birth center births attended by midwives experienced similar risks of cesarean delivery, operative vaginal delivery, transfers to hospital, severe adverse events, and other maternal morbidities when compared to nonrural women after controlling for risk factors. Our findings support continued discussion in rural communities towards incorporating community midwives as allied health care providers who can help alleviate some of the stresses on the rural maternity care system. While rural home or birth center birth may not be of interest to all rural women, rural midwives could be well positioned to provide antenatal and postpartum care to low-risk women who plan hospital deliveries in larger centers.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contribution of the many volunteers who make MANA Stats data collection possible, the hundreds of midwife contributors and their clients. The first author also thanks Kathrin Stoll, PhD for her thoughtful feedback on an earlier version of this manuscript.

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How to cite this article: Nethery E, Gordon W, Bovbjerg ML, Cheyney M. Rural community birth: Maternal and neonatal outcomes for planned community births among rural women in the United States, 2004-2009. *Birth*. 2017;00:1-10. https://doi.org/10.1111/birt.12322