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Birth Outcomes Across Three Rural-Urban Typologies in the Finger Lakes Region of New York

Kelly L. Strutz, MPH[1,2], **Ann M. Dozier, RN, PhD**[2], **Edwin van Wijngaarden, PhD**[2], and **J. Christopher Glantz, MD, MPH**[3]

[1]Department of Maternal and Child Health and Carolina Population Center, University of North Carolina, Chapel Hill, North Carolina

[2]Department of Community and Preventive Medicine, University of Rochester School of Medicine and Dentistry, Rochester, New York

[3]Department of Obstetrics and Gynecology, University of Rochester School of Medicine and Dentistry, Rochester, New York

Abstract

Purpose—The study is a descriptive, population-based analysis of birth outcomes in the New York State Finger Lakes region designed to determine whether perinatal outcomes differed across 3 rural typologies.

Methods—Hospital birth data for the Finger Lakes region from 2006-2007 were used to identify births classified as low birthweight (LBW), small for gestational age (SGA), and preterm delivery (PTD). Maternal residences were defined using 3 existing zip-code-level rural-urban typologies: Census Bureau zip codes, Rural-Urban Commuting Area codes, and Primary Service Areas. Within each typology, rural maternal characteristics and birth outcomes were compared to those in urban areas using multivariable logistic regression models.

Findings—In bivariate analyses, rurality was associated with LBW and SGA for all typologies, while PTD was associated with residence in the Census Bureau typology only. After controlling for demographic characteristics, births to mothers in the most rural level of the Census Bureau typology and to all rural mothers in the RUCA and Primary Service Area typologies were more likely to be LBW and PTD. SGA was not consistently associated with residence across typologies.

Conclusions—The typologies produced similar results for these outcomes, although effects were of greater magnitude in the RUCA and Primary Service Area typologies than in the Census Bureau typology. Comparison across typologies can have practical implications for researchers and policy makers interested in understanding the dynamics of rurality and birth outcomes in their regions.

Keywords

birth outcomes; regression analysis; residence characteristics; rural

Birthweight and period of gestation are the 2 most important predictors of an infant's survival and subsequent health status.[1-8] Infants born at low birthweight (LBW) or through preterm delivery (PTD) account for almost 70% of deaths within the first year of life[8] and are at increased risk of developing both short-term and long-term health problems with

Corresponding Author: Kelly L. Strutz, MPH, Carolina Population Center, University of North Carolina at Chapel Hill, CB# 8120, University Square, 123 W. Franklin St., Chapel Hill, NC 27516-2524, Phone: 919-448-8316, strutz@email.unc.edu.

implications for education and health care.[7] An infant whose weight is less than the 10th percentile for gestational age is known as small for gestational age (SGA) and may be at particular risk of long-term morbidity.[9] For these reasons, maternal, infant, and child health is one of 12 priority areas for the federal Office of Rural Health Policy's *Rural Healthy People 2010* project, addressing objectives to improve birth outcomes in rural areas.[10-12]

Demographic, socioeconomic, health care, and cultural characteristics of rural and urban populations differ in many respects that could contribute to disparities in perinatal health status between populations. For example, rural women are more likely than urban women to live in poverty and to have lower levels of educational attainment,[13] 2 measures of low socioeconomic status that are associated with adverse birth outcomes.[14,15] Further, rural women are more likely to be underserved by prenatal and obstetric care that can prevent pregnancy complications.[12] A recent study hypothesized that unintended pregnancy may be more common among rural women, and the study identified specific rural barriers to parental communication about contraception including isolation and stigma.[16] Unintended pregnancy can lead to poor birth outcomes through its association with risky behaviors such as prenatal smoking and unhealthy weight maintenance, higher prevalences of which have been demonstrated for rural women.[17,18]

Although New York State (NYS) is often identified with its cities, more than 3 million residents inhabit the vast majority of the state's land area outside of these cities.[19] The 9 counties of the Finger Lakes region (Chemung, Livingston, Monroe, Ontario, Schuyler, Seneca, Steuben, Wayne, and Yates) exhibit tremendous variation in population density and in economic and health care indicators that could be expected to affect perinatal health in the region, including percent of population in poverty, educational attainment, and areas defined as medically underserved or as primary care shortage areas.[20] Manufacturing remains the predominant employment sector in the region, accounting for almost 20% of the private workforce.[21] In addition, health care is an important sector. This area includes 13 hospitals with maternity centers, delivering over 14,000 infants per year. Rates of most perinatal interventions and outcomes are similar to national rates.

Multiple definitions for rurality in the US lead to ambiguity in defining rural populations, presenting a challenge for researchers interested in examining these potential disparities. Previous studies of rural-urban differences in birth outcomes used different typologies and area-level measures of rurality and yielded different results. In a national study by Larson et al of over 11 million singleton births between 1985 and 1987, residence in a nonmetropolitan county was not associated with increased risk of LBW or neonatal mortality at the national level or in most states, after controlling for demographic and biological risk factors.[22] State-based studies defining all nonmetropolitan counties as rural generally showed no dramatic difference in birth outcomes[23-26] due to the wide range of variation in health status within rural places and among population groups. Perinatal health disparities did appear in state-based studies in which zip-code level measures were used or remoteness was considered.[22,27,28] In these studies capturing some of the heterogeneity of rurality, urban-adjacent rural women demonstrated better birth outcomes while women in more remote rural locations were at risk for poorer birth outcomes.

To examine rural perinatal health, a researcher must choose the geographic area level and definition best suited to the population under study. The NYS Area Health Education Center recommends that zip code data “should be used whenever available” to reveal needs at the community level within the state.[29] Available zip-code level typologies are the US Census Bureau's zip code tabulation areas (ZCTAs)[30-33] and the zip code approximations for the Rural-Urban Commuting Area (RUCA) codes.[30,34] Health researchers have developed additional typologies to meet their needs. For instance, Nesbitt et al created a typology in

which rural residents are defined as those living within the primary service areas of a hospital designated as rural by the state Department of Health.[35-36] Comparing the place of residence with the location of the hospital of delivery allows the determination of the proportion of all hospital births that occur in facilities outside a woman's local primary service area, classifying communities into low-, medium-, and high-outflow communities.[35-36] Although this typology was not originally designed using zip codes, it can be applied to zip-code level data.

Because the rurality of the same zip code may be classified differently across typologies, examining the same data across multiple definitions may yield different results. Farmer et al demonstrated this inconsistency with infant mortality data using 3 county-level residence measures: the federal Office of Management and Budget's dichotomous metropolitan/nonmetropolitan classification, a 5-level measure based on the population size of the largest community in each county, and a 9-level measure based on the size of the largest community in the county in combination with the contiguity of the county to a metropolitan county.[37] The 9-level designation highlighted differences in infant mortality rates that were obscured in broader typologies, with higher rates of infant mortality in isolated rural counties and lower rates in rural counties that are adjacent to large population centers.

In the current study, we compared 3 typologies of rurality to evaluate the hypothesis that populations of increasing rurality have rates of LBW, PTD, and SGA which are different from those of an urban population. In order to accomplish this goal, we 1) classified rurality of the NYS Finger Lakes region using 3 zip-code-level typologies and grouped births by zip code of maternal residence; 2) described the epidemiological characteristics of perinatal health and adverse birth outcomes for singleton births to rural mothers and compared them to those of urban mothers; and 3) compared results for rural births across typologies of rurality.

Methods

Data Source

This study was a secondary analysis of a population database (birth certificate data) representing births in the 13 hospitals of the Finger Lakes region. Hospitals provided data obtained through NYS's web-based electronic birth certificate database. Home births are not included in the database. Trained birth registrars at each hospital collect data from parent interviews and prenatal and hospital records within 3 days of childbirth. The majority of the 390 specifically defined fields in the database are dichotomous and in checklist format; coders participate in monthly training and have available a manual with specific item-by-item guidance. For this study, data was de-identified except for zip code.

Study Population

This analysis of live hospital births included singleton infants born to women residing in this region in a 24-month period (2006 and 2007). Only infants born to non-Hispanic white mothers were included because there are known racial/ethnic disparities in birth outcomes[38] and 95% of the population outside of predominantly urban Monroe County is non-Hispanic white.[39] Multiple births and infants born to women residing outside of the region who delivered in the region were excluded. If a mother gave birth to more than one infant in the 24-month period, only the first birth was included.

Birth Outcomes

The primary outcomes of interest were low birthweight, preterm delivery, and small for gestational age as dichotomous events (Yes/No). LBW was defined as birthweight of less

than 2500 grams. PTD was defined as delivery before 37 weeks of gestation. SGA was defined as birthweight below the 10th percentile on a region-specific weight and gestational age distribution chart. Although national distribution charts are often used to define SGA, reference data specific to the population structure of the geographic area of interest is preferred.[9] Region-specific distributions in other areas of the US have been demonstrated to identify more SGA infants at risk for morbidity and mortality.[40] LBW most often is due to PTD, but it also can be due to inadequate fetal growth regardless of gestational age at delivery. Some LBW babies are SGA, but most are not. Similarly, some, but not all, SGA babies are LBW. For these reasons, when examining LBW, SGA was considered a confounder, and vice versa.

Primary Exposure: Rural Residence

To classify rurality, this study used zip code schema for Census Bureau, RUCA code, and Primary Service Area typologies. The definitions were applied to the zip codes of residence in the Finger Lakes region, as follows.

Census Bureau Zip Code Tabulations—The Census Bureau zip code tabulations assign both urban and rural components to each zip code from the 2000 Census as described on the Census Bureau website.[33] These were used to create a 4-level variable based on percentage of rural population: Greater than 75% rural, between 50% and 75% rural, between 25% and 50% rural, and less than 25% rural, also known as urban. In this case, the choice of a 4-level measure is somewhat arbitrary, but it was chosen to be consistent with the other typologies.

Rural-Urban Commuting Area Codes—The RUCA codes have 10 primary levels with 1-6 secondary levels each; the designations for each zip code are available on the RUCA website.[34] Cutoffs were applied to create a 4-level variable as recommended by developers on the website: urban-focused area, large rural city-focused or town-focused area, small rural town-focused area, and isolated small rural town-focused area.

Primary Service Areas—The Primary Service Area typology was designed as a 4-level categorical variable in Washington State, composed of urban, low-outflow rural, medium-outflow rural, and high-outflow rural.[35,36] To apply this coding to the Finger Lakes region, each zip code was classified as urban if its population center is closest to a hospital not designated as rural by the federal or NYS governments. The remaining zip codes were designated “rural” and further classified by outflow depending on the locations of the delivery hospitals: high-outflow (greater than 67% of people in a rural zip code deliver in an urban hospital), medium-outflow (33%-67%), and low-outflow (fewer than 33%).

Infant zip codes were the mother's zip code of residence, not mailing address. The 30 zip codes outside the Finger Lakes region or with a population center outside the region were excluded. Residents of 189 zip codes in the Finger Lakes region gave birth in 2006-2007. Of these 189 zip codes, 43 do not have associated Census Bureau zip code tabulation areas and thus were excluded from analysis for the Census Bureau typology only. All 189 zip codes were used for the RUCA and Primary Service Area typologies.

Potential Confounders

Demographic covariates considered for evaluation were maternal age (<18, 18-35, >35), education (less than high school, completed high school or GED, any post-secondary), parity (no previous pregnancies, 1-4 previous, 5 or more previous). Medical risk covariates were maternal diabetes, hypertension, depression, sexually transmitted infections (STIs), and prior PTD (all yes/no). Health care covariates were trimester began prenatal care (first, second,

third, no care), primary payor (Medicaid, private, self pay, other), provider or site of prenatal care (private physician, clinic, other, none), delivery hospital (any of 13), and type of delivery (vaginal, vaginal birth after cesarean [VBAC], primary cesarean, repeat cesarean). Other covariates were maternal alcohol and tobacco use during pregnancy (yes/no), prepregnancy BMI (<18.5, 18.5-24.9, 25-30, >30), employment during pregnancy (yes/no), and intendedness of pregnancy (wanted sooner or then, wanted later or never). Potential confounders were selected due to their established relationship with the outcomes of interest and/or with infant mortality,[2,3] and they are similar to those evaluated in previous studies of rural-urban differences in birth outcomes.[22-24,27,28]

Statistical Analysis

For each typology, bivariate analyses assessed the associations between rurality and each of these outcomes (LBW, PTD and SGA), using chi-square tests to assess statistical significance at $P < .05$. Correlations among birth outcomes within each typology were assessed with Spearman correlation coefficients. Covariates were considered confounders if associated with rurality in bivariate analyses with the chi-square test and $P < .05$. Separate logistic regressions for each outcome estimated odds ratios with 95% confidence intervals (CIs) adjusted for confounders. Because the prevalence of each outcome at birth was rare (<10%), the odds ratio was an appropriate estimation of risk. These methods tested the following 2-sided null hypothesis: there is no difference in adverse birth outcomes to mothers by rurality. All statistical analyses were performed with SAS Version 9.1 (SAS Institute Inc., Cary, North Carolina).

The study received Institutional Review Board approval from the University of Rochester.

Results

Outcomes and Characteristics by Residence

Births and birth outcomes for mothers by residence are presented in Table 1. The Census Bureau typology classified just under 50% of births as rural, while the RUCA and Primary Service Area typologies classified far fewer births as rural (approximately 21% and 15%, respectively). Overall, as shown in Table 1, 4.9% of births were LBW, 7.2% of births were PTD, and 7.4% were SGA. These birth outcomes differed by geographic stratum for each typology. Significant differences in LBW and SGA across levels of rurality were seen in all typologies, while significant differences in PTD were seen in the Census Bureau typology only. In the Census Bureau typology, the most rural zip codes had the highest proportions of all poor birth outcomes; this pattern held true for LBW and PTD using the RUCA codes as well. The RUCA typology indicated that the highest proportion of SGA occurred in city- or town-focused areas, while in the Primary Service Area typology the highest proportion of SGA occurred in the low-outflow rural zip codes that deliver at rural hospitals. LBW and PTD were correlated in this population ($r = 0.55$, $P < .0001$ for each typology). LBW was less strongly correlated with SGA ($r = 0.27$, $P < .0001$ for each), while PTD was not correlated with SGA ($r = -0.01$, *NS*).

A number of demographic characteristics were associated with residence for each typology (Table 2). Across all typologies, rural mothers in comparison to urban mothers were more likely to be younger, unemployed, and not educated beyond high school. They were also more likely to have begun prenatal care after the first trimester and less likely to have obtained this care at a clinic. Rural mothers also had higher proportions of unintended pregnancy, tobacco use, and obesity, and lower proportions of gestational diabetes than urban mothers. Additionally, there were inter-typology differences. Rural mothers were less likely to have an STI (Census Bureau and Primary Service Area) and more likely to have

had zero or more than 4 previous pregnancies (RUCA and Primary Service Area) or prior PTD (Census Bureau). Differences in these characteristics among levels of rurality can be seen in Table 2. At some levels of rurality, residents had higher proportions of depression and lower proportions of private medical insurance and delivery by VBAC. Hypertension and alcohol use did not differ across residence in any typology.

Logistic Regression Results

The following significant characteristics (as presented in Table 2) were controlled for in regression analyses in all 3 typologies: delivery hospital, age group, education, depression, trimester began care, primary payor, prenatal care provider, tobacco use, prepregnancy BMI, employment, and intendedness. Additionally, the analyses for the Census Bureau typology controlled for STIs and prior PTD, the analyses for the RUCA typology controlled for previous pregnancies and delivery type, and the analyses for the Primary Service Area typology controlled for STIs, previous pregnancies, and delivery type. After adjustment, some associations were seen between birth outcomes and rurality. Table 3 shows adjusted odds ratios (OR) with 95% confidence intervals (CI), comparing each level of rurality to the urban reference group after adjustment for statistically significant confounders. Births to mothers in the highest level of rurality in the Census Bureau typology, and to all rural mothers in the RUCA and Primary Service Area typologies, were more likely to be LBW and PTD. ORs for these ranged from 1.57-3.23. SGA was generally not associated with residence, although the isolated rural group in the RUCA typology demonstrated a protective effect of rurality on SGA (OR = 0.66 [CI 0.49-0.91]).

Discussion

Our study classified rurality of the Finger Lakes region using 3 zip-code-level typologies with 4 levels of residence each. The overall proportions of LBW and PTD in our singleton, non-Hispanic white population (approximately 5% and 7%, respectively) and the proportions at each stratum in every typology were lower than the national average for 2006 (LBW, 8.3%; PTD, 12.8%; these national figures include all minorities and multiple births).[41] *Healthy People 2010* targets were 5% for LBW and 7.6% for PTD; these targets were raised to 7.8% and 11.4%, respectively, for *Healthy People 2020*.[42,43] The overall proportion of SGA in our population, 7.4%, was lower than the 10th percentile on the region-specific growth chart; however, large and small town-focused residences in the RUCA codes and high-outflow rural residences in the Primary Service Area typology were at approximately 10%, and low-outflow rural residences in the Primary Service Area typology were at 11.6%. In the Census Bureau typology, the most rural zip codes had the highest proportions of all poor birth outcomes; this pattern held true for LBW and PTD using the RUCA codes as well.

After controlling for confounders, rural women had higher odds of LBW and PTD but not consistently of SGA than urban women. LBW and PTD are highly correlated in general and in this population. In contrast, SGA was not correlated with the other birth outcomes. Our results, demonstrating many similarities between LBW and PTD across typologies but less so for SGA, were consistent with this correlation pattern. Infants in the most isolated residences as defined by the RUCA codes did have lower odds of SGA, although SGA did not differ significantly for any other stratum in any typology. This discrepant finding is consistent with Luo and Wilkins' study of birth outcomes in Québec, which also demonstrated lower risk of SGA in only the most isolated rural areas.[44] Because our regression analyses of SGA controlled for LBW, our finding suggests that characteristics of rural residence do not contribute to fetal growth restriction for infants born at weights greater than 2500 grams, and instead rural residence may be protective for SGA in the most isolated areas. Unmeasured characteristics of rural areas that may reduce SGA specifically[45]

include the availability of fresh fruits and vegetables[46] and potentially lower levels of asthma-inducing air pollutants.[47]

Our zip-code-level measures provided for a more nuanced analysis than that of LBW across rural and urban areas in NYS found in the national study by Larson and colleagues.[22] In Larson's study, rural counties in NYS not adjacent to urban ones exhibited a 12% greater risk of LBW than urban counties after adjusting for confounders, while rural counties adjacent to urban ones exhibited a 5% lower risk of LBW than urban ones. Hillemeier and associates conducted the only study to use zip-code-level RUCA codes in the US, comparing LBW and PTD among singleton first births to women in central Pennsylvania, a region neighboring the Finger Lakes region.[28] In that population, women in zip codes designated as “large rural city-focused” by the RUCA codes had lower rates of LBW and PTD than those in urban zip codes, while communities designated “small town-focused” and “isolated rural” had rates similar to those of urban zip codes. Births to African-American and Latina women were included in that analysis.

Level of rurality in our regression analyses was not associated with LBW and PTD for the RUCA and Primary Service Area typologies, although the magnitudes of effects differed by stratum. Therefore, differentiating degree of rurality by itself had only a modest effect for understanding predictors associated with these outcomes. Results for all 3 typologies were relatively consistent despite the fact that zip codes were not always classified at the same degree of rurality across typologies. However, the magnitudes of associations were greater for the RUCA and Primary Service Area typologies than for the Census Bureau typology. These results suggest that, although each of the 3 typologies is usable, the Census Bureau typology may underestimate rural-urban differences in birth outcomes.

In our region, the Census Bureau classified 13.4% of the total births as occurring to residents within the most rural category—comparable to the 15% classified as residing within all rural levels in the Primary Service Area typology but less than the 21% classified as residing within all rural levels in the RUCA typology. This is a plausible reason why only the most rural births as defined by the Census Bureau had significantly higher odds of LBW and PTD, even though all rural births as defined by the other typologies had significantly higher odds of these outcomes. The Primary Service Area's low total percentage of rurality is due to the small number of hospitals in the Finger Lakes region with maternity services that are designated rural by the federal or NYS governments. Some hospitals that might anecdotally be considered rural by local residents are not designated rural by the federal or state governments, and therefore mothers in primary service areas of these hospitals were classified as urban.

As originally designed by Nesbitt and colleagues,[35,36] the high-outflow communities in the Primary Service Area typology were the most rural and had the highest risks of adverse birth outcomes.[36] Our results suggest that this is not true within the Finger Lakes region. Instead, low-outflow communities in our study had the highest odds of LBW and PTD, and the highest proportions of maternal characteristics that were associated with the most rural levels in the other typologies (eg, younger age, lower educational attainment). Therefore, we can conclude that the most rural communities in our region, in contrast to Washington State, are those in which most residents gave birth in the local, rural-designated hospitals.

Because health care access is widely considered to be the largest barrier faced by rural populations, it is not surprising that many medical or health care characteristics differed by degree of rurality in our study. Focus groups across the state have identified rural health care concerns including a shortage of obstetricians and maternity hospitals in rural areas, competition among rural hospitals, and restrictive insurance.[19] In rural NYS, even

individuals with health insurance coverage may face limited options for accessing services due to lack of specialists in the community, overburdened physicians' offices, or inadequate transportation.[48] In a 2007 survey, 14% of rural New Yorkers reported at least one occasion in the past 12 months in which they had needed to see a doctor but could not, with fewer than half attributing this to lack of health insurance.[48] It should be noted that even after controlling for medical and health care variables, rural areas in the Finger Lakes region continued to demonstrate higher risk of LBW and PTD.

Limitations

Limitations of this study include those inherent in using birth certificate data: for instance, data accuracy, completeness, and potential for misclassification.[49-53] Birth certificate accuracy is dependent upon its coders; Finger Lakes region birth registrars undergo training and receive feedback to help reduce this obstacle. The birth certificate data may not include all covariates we would like to consider, or it may involve missing or incomplete data for fields of interest (eg, illegal drug use). It is worth noting that the measures used in this study are among the most reliable and valid.[49-51] Further, the use of a closed-ended checkbox format and training of medical records personnel have helped to improve sensitivity and positive predictive value of birth certificate data in recent years.[52,53]

Another limitation of the study is that it captures only births in hospitals. Hospital deliveries account for the majority of births in the Finger Lakes region. However, births occurring at home, including those to women in Amish and Mennonite communities, were not included in the analysis. Additionally, we are missing births to women residing in the region who delivered outside of these 9 counties. The population also excluded multiple gestations and minorities, 2 groups at higher risk of poor birth outcomes, and the results should not be generalized to these groups.

Conclusions and Implications

Birth outcomes and predictors were relatively consistent for births to rural mothers in the Finger Lakes region regardless of the typology used, although the magnitudes of the associations varied. The use of multiple typologies of rurality and zip-code-level measures may have minimized misclassification bias. Moreover, the use of the hospital birth data allows inclusion of the full population in the region rather than a sample, with standard definitions of outcomes and covariates of interest to the maternal and child health field.

Because of these strengths, this study has implications for intervention planning and policy. First, it supports the examination of variability across levels of rurality to identify risk factors of greater or lesser importance for health promotion programs. In addition to the maternal characteristics that we have identified, unexplained differences in birth outcomes between rural and urban populations in our regression analyses presumably can be attributed to characteristics within these settings that are not available in birth record data. State and local maternal and child health organizations may benefit from identifying additional risk factors of interest to develop interventions. Multifactorial approaches likely will be needed to address increased risk of LBW and PTD in rural areas of this region. Further, this study demonstrates the feasibility and added value of comparing data across different rural/urban typologies. Given the Census Bureau typology's classification of more births as rural, and the differences in magnitudes of effects among typologies, researchers and policy makers would benefit from replicating the typology comparisons in their own communities to assess the needs of rural populations and to develop targeted prevention efforts. Tailoring perinatal health interventions to the particular rural context of a community will be critical to equalize birth outcomes between rural and urban populations.

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References

1. McCormick MC, Behrman RE. The quiet epidemic of premature birth: commentary on a recent Institute of Medicine report. Ambul Pediatr. 2007; 7:8–9. [PubMed: 17261476]
2. Committee to Study the Prevention of Low Birthweight, Institute of Medicine. Preventing Low Birthweight. Washington, DC: National Academy Press; 1985.
3. Berkowitz GS, Papiernik E. Epidemiology of preterm birth. Epidemiol Rev. 1993; 15:414–443. [PubMed: 8174665]
4. McCormick MC. The contribution of low birth weight to infant mortality and childhood morbidity. N Engl J Med. 1985; 312:82–90. [PubMed: 3880598]
5. Starfield B, Shapiro S, McCormick M, Bross D. Mortality and morbidity in infants with intrauterine growth retardation. J Pediatr. 1982; 101:978–983. [PubMed: 6890576]
6. Fitzhardinge PM, Steven EM. The small-for-date infant. II. Neurologic and intellectual sequelae. Pediatrics. 1972; 50:50–57. [PubMed: 5038108]
7. Behrman, RE.; Butler, AS. Preterm Birth: Causes, Consequences, and Prevention. Washington, DC: National Academies Press; 2006.
8. Mathews TJ, MacDorman MF. Infant mortality statistics from the 2004 period linked birth/infant death data set. Natl Vital Stat Rep. 2007; 55:1–32. [PubMed: 17569269]
9. Saenger P, Czernichow P, Hughes I, Reiter EO. Small for gestational age: short stature and beyond. Endo Rev. 2007; 28:219–251.
10. Gamm, LD.; Hutchison, LL.; Dabney, BJ., editors. Rural Healthy People 2010: a companion document to Healthy People 2010. College Station, TX: The Texas A&M University System Health Science Center, School of Rural Public Health, Southwest Rural Health Research Center; 2003.
11. Gamm L, Hutchison L, Bellamy G, Dabney BJ. Rural Healthy People 2010: identifying rural health priorities and models for practice. J Rural Health. 2002; 18:9–14. [PubMed: 12043760]
12. Peck, J.; Alexander, K. Maternal, infant, and child health in rural areas. In: Gamm, LD.; Hutchison, LL.; Dabney, BJ., editors. Rural Healthy People 2010: a companion document to Healthy People 2010. Vol. 1. College Station, TX: The Texas A&M University System Health Science Center, School of Rural Public Health, Southwest Rural Health Research Center; 2003. p. 151-153.
13. Bushy A. Health issues of women in rural environments: an overview. J Am Med Womens Assoc. 1998; 53:53–56. [PubMed: 9595896]
14. Parker JD, Schoendorf KC, Kiely JL. Associations between measures of socioeconomic status and low birth weight, small for gestational age, and premature delivery in the United States. Ann Epidemiol. 1994; 4:271–278. [PubMed: 7921316]
15. Blumenshine P, Egerter S, Barclay CJ, Cubbin C, Braveman PA. Socioeconomic disparities in adverse birth outcomes: a systematic review. Am J Prev Med. 2010; 39:263–272. [PubMed: 20709259]
16. Noone J, Young HM. Preparing daughters: the context of rurality on mothers' role in contraception. J Rural Health. 2009; 25:282–289. [PubMed: 19566614]
17. Bailey BA, Jones Cole LK. Rurality and birth outcomes: findings from Southern Appalachia and the potential role of pregnancy smoking. J Rural Health. 2009; 25:141–149. [PubMed: 19785579]
18. Bove CF, Olson CM. Obesity in low-income rural women: qualitative insights about physical activity and eating patterns. Women Health. 2006; 44:57–78. [PubMed: 17182527]

19. New York State Rural Initiative. [Accessed 05/12/11] A vision for rural New York. 2006. Available at http://devsoc.cals.cornell.edu/cals/devsoc/outreach/cardi/programs/indicators/rvp/upload/rvp-summary_report.pdf
20. Rural Policy Research Institute. New York: 2006. Demographic and economic profile. Available at http://www.rupri.org/Forms/NewYork.pdf
21. Office of the State Comptroller. [Accessed 05/12/11] The changing manufacturing sector in Upstate New York: opportunities for growth. Available at: http://osc.state.ny.us/localgov/pubs/research/manufacturingreport.pdf
22. Larson EH, Hart LG, Rosenblatt RA. Is non-metropolitan residence a risk factor for poor birth outcome in the US? Soc Sci Med. 1997; 45:171–188. [PubMed: 9225406]
23. Hulme PA, Blegen MA. Residential status and birth outcomes: is the rural/urban distinction adequate? Public Health Nurs. 1999; 16:176–181. [PubMed: 10388334]
24. Alexy B, Nichols B, Heverly MA, Garzon L. Prenatal factors and birth outcomes in the public health service: a rural/urban comparison. Res Nurs Health. 1997; 20:61–70. [PubMed: 9024478]
25. Rock SM, Straub LA. Birth outcomes to rural Illinois residents: is there a crisis? J Rural Health. 1994; 10:122–130. [PubMed: 10134713]
26. Hueston WJ. Prenatal care and low-birth-weight rates in urban and rural Wisconsin. J Am Board Fam Pract. 1995; 8:17–21. [PubMed: 7701955]
27. Larson EH, Hart LG, Rosenblatt RA. Rural residence and poor birth outcome in Washington State. J Rural Health. 1992; 8:162–170. [PubMed: 10121544]
28. Hillemeier MM, Weisman CS, Chase GA, Dyer AM. Individual and community predictors of preterm birth and low birthweight along the rural-urban continuum in central Pennsylvania. J Rural Health. 2007; 23:42–48. [PubMed: 17300477]
29. New York State Area Health Education Center System. A ZIP code analysis of primary care need in New York State. 2006. Available at http://www.ahec.buffalo.edu/reports/zipcode_pc_need_report.pdfAccessed 05/12/11
30. Hall SA, Kaufman JS, Ricketts TC. Defining urban and rural areas in US epidemiologic studies. J Urban Health: Bull NY Acad Med. 2006; 83:162–175.
31. US Census Bureau. [Accessed 05/12/11] Home page. Available at http://www.census.gov
32. US Department of Agriculture, Economic Research Service. [Accessed 05/12/11] Rural definitions for New York. Available at http://www.ers.usda.gov/data/ruraldefinitions/ny.pdf
33. US Census Bureau. [Accessed 05/12/11] Zip Code Tabulation Areas. Available at http://www.census.gov/geo/ZCTA/zcta.html
34. University of Washington. [Accessed 05/12/11] Rural Health Research Center. Rural Urban Commuting Area Codes. Available at http://depts.washington.edu/uwruca/
35. Nesbitt TS, Rosenblatt RA. Access to maternity care in rural Washington: its effect on neonatal outcomes and resource use. Am J Public Health. 1997; 87:85–90. [PubMed: 9065233]
36. Nesbitt TS, Connell FA, Hart LG, Rosenblatt RA. Access to obstetric care in rural areas: effect on birth outcomes. Am J Public Health. 1990; 80:814–818. [PubMed: 2356904]
37. Farmer FL, Clarke LL, Miller MK. Consequences of differential residence designations for rural health policy research: the case of infant mortality. J Rural Health. 1993; 9:17–26. [PubMed: 10124197]
38. James SA. Racial and ethnic differences in infant mortality and low birth weight: a psychosocial critique. Ann Epidemiol. 1993; 3:130–136. [PubMed: 8269064]
39. New York State Department of Health. [Accessed 05/12/11] 2000 US Census Bureau State and County Profiles. Available at http://www.health.state.ny.us/statistics/chac/census/census_map.htm
40. Odibo AO, Francis A, Cahill AG, Macones GA, Crane JP, Gardosi J. Association between pregnancy complications and small-for-gestational-age birth weight defined by customized fetal growth standard versus a population-based standard. J Matern Fetal Neonatal Med. 2011; 24:411–417. [PubMed: 20698736]
41. Martin JA, Kung HC, Mathews TJ, et al. Annual summary of vital statistics: 2006. Pediatrics. 2008; 121:788–801. [PubMed: 18381544]

42. US Department of Health and Human Services, Public Health Service. Healthy People 2010: Understanding and improving health. Washington, DC: 2000.
43. US Department of Health and Human Services, Public Health Service. Healthy People 2020. Washington, DC: 2010. Available at http://www.healthypeople.gov/2020/default.aspx
44. Luo ZC, Wilkins R. Degree of rural isolation and birth outcomes. Paediatr Perinat Epidemiol. 2008; 22:341–349. [PubMed: 18578747]
45. McCowan L, Horgan RP. Risk factors for small for gestational age infants. Best Pract Res Clin Obstet Gynaecol. 2009; 23:779–793. [PubMed: 19604726]
46. Hosler AS. Retail food availability, obesity, and cigarette smoking in rural communities. J Rural Health. 2009; 25:203–210. [PubMed: 19785588]
47. Schwartz DA. Etiology and pathogenesis of airway disease in children and adults from rural communities. Environ Health Perspect. 1999; 107(suppl 3):393–401. [PubMed: 10346988]
48. Blakely, RM.; Simon, KI. Rural New York Minute. Vol. 5. Ithaca, NY: Cornell University Community and Rural Development Institute; 2007. Health care access in rural NY: it's not just about having health insurance. Available at http://devsoc.cals.cornell.edu/cals/devsoc/outreach/cardi/publications/upload/05-2007-RNYM.pdf
49. Northam S, Knapp TR. The reliability and validity of birth certificates. JOGNN. 2006; 35:3–12. [PubMed: 16466348]
50. Roohan PJ, Josberger RE, Acar J, et al. Validation of birth certificate data in New York State. J Community Health. 2003; 28:335–346. [PubMed: 14535599]
51. Gore DC, Chez RA, Remmel RJ, et al. Unreliable medical information on birth certificates. J Reprod Med. 2002; 47:297–302. [PubMed: 12012881]
52. Reichman NE, Hade EM. Validation of birth certificate data: A study of women in New Jersey's Healthstart program. Ann Epidemiol. 2001; 11:186–193. [PubMed: 11248582]
53. Buescher PA, Taylor KP, Davis MH, Bowling JM. The quality of the new birth certificate data: A validation study in North Carolina. Am J Public Health. 1993; 83:1163–1165. [PubMed: 8342728]

Table 1

Percentage of Hospital Births and Birth Outcomes to Mothers in the Finger Lakes Region of New York State by Residence, 2006-2007

	Total Births		LBW	PTD	SGA
Typology	**N**	**%**	**%**	**%**	**%**
Census Bureau	19,475*	100	4.8	7.1	7.4
Urban (<25% rural)	10,276	52.8	4.9	7.2	7.1
25-50% rural	5156	26.5	4.3	6.2	7.5
50-75% rural	1433	7.4	4.8	7.5	6.9
>75% rural	2610	13.4	5.9	8.4	8.9
			$P = .01$	$P = .004$	$P = .02$
RUCA	19,576*	100	4.9	7.2	7.4
Urban-focused area	15,516	79.3	4.6	6.9	7.0
Large rural city/town-focused area	1973	10.1	5.5	7.4	9.7
Small rural town-focused area	926	4.7	5.7	7.9	9.7
Isolated	1161	5.9	6.4	9.0	8.1
			$P = .01$	$P = .05$	$P < .0001$
Primary Service Area	19,576*	100	4.9	7.2	7.4
Urban	16,599	84.8	4.6	7.0	7.0
Low-outflow rural	760	3.9	5.8	8.6	11.6
Medium-outflow rural	1717	8.8	6.4	8.3	8.8
High-outflow rural	500	2.6	5.4	7.6	10.0
			$P = .01$	$P = .07$	$P < .0001$

*Birth data from 146 zip codes in the Census Bureau typology and 189 zip codes in the RUCA and Primary Service Area typologies.

Table 2

Demographic, Biological, Health Care, and Other Characteristics for Mothers in the Finger Lakes Region of New York State by Residence, 2006-2007

Characteristic	% by Census Bureau Code (N=19,475*)				% by RUCA Code (N=19,576*)				% by Primary Service Area Code (N=19,576*)			
	Urban (N=10,276)	25-50% Rural (N=5156)	50-75% Rural (N=1433)	75-100% Rural (N=2610)	Urban (N=15,516)	Large Rural City/ Town Focused Area (N=1973)	Small Rural Town-Focused Area (N=926)	Isolated (N=1161)	Urban (N=16,599)	Low-Outflow Rural (N=760)	Medium-Outflow Rural (N=1717)	High-Outflow Rural (N=500)
Age group (years)												
<18	1.5	1.8	1.4	2.5	1.4	2.7	2.4	2.9	1.6	3.3	2.0	2.6
18-35	83.9	87.0	83.5	87.2	84.3	87.9	89.3	88.6	84.6	89.6	88.4	86.8
>35	14.7	11.2	15.1	10.3	14.3	9.4	8.3	8.4	13.9	7.1	9.6	10.6
				P < .0001				*P* < .0001				*P* < .0001
Education												
Some high school or less	9.7	9.7	8.5	13.8	8.9	14.3	13.4	17.0	9.5	17.6	13.0	10.6
Completed high school or equivalent	20.5	26.5	23.6	30.3	21.9	26.7	33.9	34.7	22.7	29.6	28.4	31.2
Any post-secondary	69.8	63.8	67.9	55.9	69.2	59.0	52.7	48.3	67.8	52.8	58.7	58.2
				P < .0001				*P* < .0001				*P* < .0001
Previous pregnancies												
0	31.6	31.7	30.3	31.9	31.5	30.7	34.4	32.6	31.3	31.1	33.1	35.3
1-4	63.7	63.5	64.9	62.5	64.0	64.3	58.7	60.7	63.9	64.1	60.7	60.9
5+	4.7	4.8	4.8	5.6	4.6	5.0	6.9	6.7	4.8	4.9	6.2	3.8
				P = .49				*P* = .0001				*P* = .02
Gestational diabetes												
Yes	4.1	3.6	3.4	2.8	4.1	2.4	2.4	2.8	4.0	2.1	2.9	3.0
No	95.9	96.5	96.6	97.2	95.9	97.6	97.6	97.2	96.1	97.9	97.2	97.0
				P = .01				*P* < .0001				*P* = .01
Hypertension												
Yes	5.2	5.3	5.5	4.9	5.3	4.9	6.3	4.3	5.2	5.0	6.1	4.6
No	94.8	94.7	94.5	95.1	94.7	95.1	93.7	95.7	94.8	95.0	93.9	95.4
				P = .87				*P* = .20				*P* = .34
Depression												

Characteristic	% by Census Bureau Code (N=19,475*)				% by RUCA Code (N=19,576*)				% by Primary Service Area Code (N=19,576*)			
	Urban (N=10,276)	25-50% Rural (N=5156)	50-75% Rural (N=1433)	75-100% Rural (N=2610)	Urban (N=15,516)	Large Rural City/ Town Focused Area (N=1973)	Small Rural Town-Focused Area (N=926)	Isolated (N=1161)	Urban (N=16,599)	Low-Outflow Rural (N=760)	Medium-Outflow Rural (N=1717)	High-Outflow Rural (N=500)
Yes	7.9	9.7	7.7	9.1	8.0	10.5	11.1	10.5	8.4	12.5	8.4	7.7
No	92.1	90.3	92.3	90.9	92.0	89.5	89.0	89.5	91.6	87.5	91.6	92.3
				P = .003				*P* < .0001				*P* = .003
STIs												
Yes	3.6	3.1	2.6	2.3	3.3	3.1	3.4	2.2	3.5	1.2	2.5	1.6
No	96.4	96.9	97.4	97.7	96.7	96.9	96.7	97.8	96.6	98.8	97.6	98.4
				P = .002				*P* = .25				*P* = .0001
Prior PTD												
Yes	2.9	2.4	3.8	3.1	2.9	2.5	2.7	2.4	2.8	2.8	3.0	2.8
No	97.1	97.6	96.2	96.9	97.1	97.5	97.3	97.6	97.2	97.2	97.0	97.2
				P = .03				*P* = .51				*P* = .97
Trimester began care												
First	84.3	82.8	81.4	78.9	83.8	83.3	76.5	75.2	83.2	82.7	81.0	78.1
Second	13.5	14.8	16.0	17.8	14.0	13.8	20.4	20.5	14.4	15.0	15.8	19.1
Third	2.2	2.3	2.5	3.3	2.2	2.8	3.0	4.2	2.3	2.2	2.9	2.8
No care	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.0
				P < .0001				*P* < .0001				*P* = .04
Primary payor												
Private	72.8	64.3	73.2	54.8	72.6	53.2	49.0	49.8	71.0	46.2	54.4	54.9
Medicaid	25.8	32.5	23.5	38.0	25.7	41.3	44.5	41.3	26.7	48.3	40.0	40.5
Self-pay	0.5	1.2	1.2	3.3	0.6	2.5	3.2	4.0	1.0	1.7	2.6	2.0
Other	0.8	2.0	2.2	3.9	1.1	3.0	3.2	4.9	1.4	3.8	3.1	2.6
				P < .0001				*P* < .0001				*P* < .0001
Prenatal care provider												
Private physician	93.3	97.3	96.4	97.9	94.4	98.9	97.7	97.8	94.7	98.4	98.3	98.0
Clinic	6.4	2.4	3.6	1.8	5.3	1.0	1.7	1.8	5.0	1.5	1.4	1.6
Other	0.3	0.3	0.1	0.4	0.3	0.2	0.5	0.4	0.3	0.1	0.4	0.4
				P < .0001				*P* < .0001				*P* < .0001

Characteristic	% by Census Bureau Code (N=19,475*)				% by RUCA Code (N=19,576*)				% by Primary Service Area Code (N=19,576*)			
	Urban (N=10,276)	25-50% Rural (N=5156)	50-75% Rural (N=1433)	75-100% Rural (N=2610)	Urban (N=15,516)	Large Rural City/ Town Focused Area (N=1973)	Small Rural Town-Focused Area (N=926)	Isolated (N=1161)	Urban (N=16,599)	Low-Outflow Rural (N=760)	Medium-Outflow Rural (N=1717)	High-Outflow Rural (N=500)
Delivery type												
Vaginal	69.3	69.5	68.1	67.7	69.0	68.5	71.2	67.9	69.2	67.8	67.4	69.4
Vaginal birth after cesarean	1.4	1.3	1.8	1.0	1.5	1.1	0.8	0.9	1.5	0.8	0.8	0.8
Primary cesarean	18.0	17.9	17.7	18.3	17.9	19.1	18.8	17.7	17.9	17.4	20.0	17.6
Repeat cesarean	11.3	11.3	12.4	13.0	11.7	11.4	9.3	13.6	11.5	14.1	11.7	12.2
				P = .18				*P* = .03				*P* = .04
Alcohol use												
Yes	1.2	1.2	0.7	1.2	1.1	1.6	0.8	1.6	1.2	1.2	1.2	0.0
No	98.8	98.8	99.3	98.9	98.9	98.4	99.2	98.5	98.8	98.8	98.8	100.0
				P = .36				*P* = .13				*P* = .11
Tobacco use												
Yes	22.2	29.8	25.6	34.4	23.4	35.4	38.0	37.2	24.5	42.5	32.3	35.9
No	77.8	70.3	74.4	65.6	76.6	64.6	62.0	62.8	75.5	57.5	67.7	64.1
				P < .0001				*P* < .0001				*P* < .0001
Prepregnancy BMI												
Underweight (<18.5)	7.8	7.3	5.7	7.1	7.6	6.7	7.0	6.2	7.7	5.0	6.5	5.6
Appropriate (18.5-24.9)	50.0	46.4	47.5	41.5	48.8	45.2	41.1	42.7	48.1	46.3	45.3	44.2
Overweight (25-30)	22.6	22.7	24.4	25.7	23.2	21.7	24.3	24.0	23.1	23.0	23.4	24.2
Obese (>30)	19.6	23.6	22.4	25.6	20.4	26.4	27.5	27.1	21.1	25.7	24.8	26.0
				P < .0001				*P* < .0001				*P* < .0001
Employment												
Yes	69.8	70.1	70.1	62.9	70.4	66.8	61.6	59.2	70.0	61.6	62.6	66.6
No	30.3	29.9	29.9	37.1	29.6	33.2	38.4	40.8	30.0	38.4	37.5	33.4
				P < .0001				*P* < .0001				*P* < .0001
Intendedness												
Wanted sooner or then	73.7	66.1	72.4	62.6	72.6	60.5	59.5	61.7	71.8	54.8	63.1	61.5
Wanted later or never	26.3	33.9	27.6	37.4	27.4	39.5	40.5	38.3	28.2	45.2	36.9	38.5
				P < .0001				*P* < .0001				*P* < .0001

Characteristic	% by Census Bureau Code (N=19,475*)				% by RUCA Code (N=19,576*)				% by Primary Service Area Code (N=19,576*)			
	Urban (N=10,276)	25-50% Rural (N=5156)	50-75% Rural (N=1433)	75-100% Rural (N=2610)	Urban (N=15,516)	Large Rural City/ Town Focused Area (N=1973)	Small Rural Town-Focused Area (N=926)	Isolated (N=1161)	Urban (N=16,599)	Low-Outflow Rural (N=760)	Medium-Outflow Rural (N=1717)	High-Outflow Rural (N=500)
Delivery hospital				*P* < .0001				*P* < .0001				*P* < .0001

*Actual number of cases for various characteristics may vary slightly because of missing data.

Table 3

Regression Analysis of Birth Outcomes Adjusted by Demographic, Medical, Health Care, and Other Characteristics for Hospital Births to Rural Mothers in the Finger Lakes Region of New York State, 2006-2007

	LBW		PTD		SGA	
Maternal Residence	**Adjusted OR***	**(95% CI)**	**Adjusted OR***	**(95% CI)**	**Adjusted OR***	**(95% CI)**
Census Bureau (N=14,885) (Reference: urban)						
25-50% rural	1.18	(0.94, 1.49)	1.03	(0.86, 1.24)	0.92	(0.76, 1.10)
50-75% rural	1.29	(0.93, 1.80)	1.12	(0.86, 1.46)	1.02	(0.78, 1.33)
>75% rural	1.65†	(1.22, 2.23)	1.57†	(1.24, 1.98)	0.98	(0.78, 1.24)
RUCA (N=14,958) (Reference: urban)						
Large rural area	2.96†	(2.06, 4.27)	1.98†	(1.47, 2.65)	0.84	(0.63, 1.12)
Small rural area	2.22†	(1.46, 3.39)	1.82†	(1.30, 2.55)	0.97	(0.71, 1.33)
Isolated	3.26†	(2.22, 4.80)	2.43†	(1.81, 3.27)	0.66†	(0.49, 0.91)
Primary Service Area (N=14,958) (Reference: urban)						
Low-outflow rural	3.23†	(1.91, 5.47)	3.02†	(1.98, 4.63)	0.78	(0.51, 1.19)
Medium-outflow rural	2.43†	(1.71, 3.46)	2.15†	(1.63, 2.85)	0.82	(0.60, 1.12)
High-outflow rural	1.80†	(1.07, 3.03)	1.60†	(1.03, 2.48)	0.92	(0.61, 1.40)

*The following significant demographic, medical, health care, and other characteristics (as presented in Table 2) were controlled for in regression analyses in all 3 typologies: delivery hospital, age group, education, depression, trimester began care, primary payor, prenatal care provider, tobacco use, prepregnancy BMI, employment, intendedness. Additionally, the analyses for the Census Bureau typology controlled for STIs and prior PTD, the RUCA typology controlled for previous pregnancies and delivery type, and the Primary Service Area typology controlled for STIs, previous pregnancies, and delivery type. All analyses for LBW controlled for SGA and vice versa.

†Significant at $P < .05$.