

## Birth Outcomes Related to Distance in Rural and Frontier Kansas

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### ABSTRACT

**Introduction.** Women from rural communities must travel greater distances to secure obstetrical care. This study sought the extent to which distance traveled by mothers for obstetrical services affects birth outcomes in rural and frontier counties of Kansas.

**Methods.** Medical students invited women over the age of 18 to participate in a recall survey regarding their children under three years old. Participants were a sample of convenience, and the length of data collection was a month. A bivariate analysis was performed on the responses gathered regarding obstetrical measures as a function of self-reported distance traveled to the hospital of delivery.

**Results.** Eighty-five women completed the survey, but only 76 satisfied all eligibility requirements. No statistical difference in birth outcomes were found between women who travel more than or less than 20 miles. However, when correlating data to that of the Kansas Hospital Association and the Kansas Department of Health and Environment, counties without birth facilities had a higher percentage of very low birth weights (< 1,500 grams) and more babies born at full-term when compared to counties that offer birth facilities. Babies born to mothers who reside in counties with obstetrical services were born at an earlier gestational age than those without birth facilities. Lastly, babies born into a family with income less than \$50,000 weighed less and had a shorter gestational age than those from a more affluent household.

**Conclusions.** The results revealed counterintuitive findings that deserve to be explored further by a study with greater statistical power.

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### INTRODUCTION

Accessing obstetrical care in the U.S. has become a growing concern in rural settings due to a continual decline of obstetrician-gynecologists (OB-GYN) delivering babies and family medicine maternity (FM-Mat) physicians.<sup>1,2</sup> Although 75% of the land in the U.S. is rural, there is a disproportionate distribution of the physician workforce in nonmetropolitan regions. Central and mountain west states have the highest proportion of counties without an OB-GYN.<sup>2</sup> In 2008, it was estimated that only 6.4% of OB-GYN specialists practiced in rural settings, and of the family physicians who practiced in rural settings, only 19.2% performed routine deliveries.<sup>3</sup> Rayburn et al.<sup>2</sup> found approximately 49% of the 3,143 counties of the U.S. lack obstetrical services. The impact of this disparity can be appreciated further at an individual state level.

A recent study reported that 94 out of the 96 practicing physicians

in Frontier counties of Kansas identified themselves as family medicine physicians, and only 19 of these were FM-Mat physicians.<sup>4</sup> There were no OB-GYN physicians present in these counties. Similarly, out of 212 practicing physicians in rural counties of Kansas, 115 identified themselves as family medicine doctors and from these only 43 offered maternity care services. Moreover, out of the 561 practicing physicians in densely settled rural counties, 164 identified themselves as family medicine physicians and 26 as OB-GYNs. However, only 36 from the 164 family medicine physicians and only 19 from the 26 OB-GYNs offered obstetrical care at the time of survey collection.<sup>5</sup> These statistics are concerning for rural communities, since FM-Mat physicians provide the majority of obstetrical care services to about one-third of all newborns.<sup>3</sup> Currently, it was projected that by 2030, only 24 counties of the 89 non-urban counties in Kansas will have at least one provider who offers obstetrical care.<sup>5</sup>

Due to the disparity of obstetrical services in rural communities, many women travel farther than 80 km to the nearest facility to secure prenatal and obstetrical care.<sup>5</sup> As a consequence of the barriers that patients experience when accessing these medical services, there was a concern that it may become less likely for these rural women to receive an equivalent level of care as those women who receive care locally.<sup>6</sup> In this study, we explored the extent to which distance traveled by mothers for obstetrical services affected birth outcomes in rural and frontier counties of Kansas.

### METHODS

This study was approved by the University of Kansas Medical Center Institutional Review Board.

**Study Population.** The population used for this study was a convenience sample of women who delivered a child in rural or frontier Kansas and whose child was less than three years of age at the time of survey collection between June 22 and July 17, 2020. All participants were at least 18 years old at the time of survey collection. This survey was offered to women in clinics by medical students participating in the 2020 University of Kansas School of Medicine (KUSM) Summer Teaching Option for Rural Medicine (STORM) program. The women ultimately chose to participate or not. Table 1 shows the demographics (age and ethnicity) of study participants compared to the Kansas Department of Health and Environment (KDHE) data. The annual household income and educational level could not be compared with the KDHE data. Any discrepancies within the number for survey participants were due to participants not disclosing that information.

The Population Density Peer Groups (PDPG) from the study were defined based on the average number of persons per square mile (ppsm) in a county of Kansas.<sup>7</sup> The following definitions were used: frontier: less than 6.0 ppsm, rural: 6.0 - 19.9 ppsm, densely settled rural: 20.0 - 39.9 ppsm, semi-urban: 40.0 - 149.9 ppsm, urban: 150.0 or more ppsm.

**Exclusion Criteria.** Exclusion criteria consisted of women who had children equal to or greater than three years old, who delivered in semi-urban and urban counties, who delivered in another state that was not Kansas, or participants who were under the age of 18 at the time of survey collection.

**Table 1. Respondent demographics.**

Demographics	Category	Frequency (N = 76)	Percent	KDHE (N = 9,552)	Percent	p Value
Age	18-24	17	22.4	2,831	29.6	NS*
	25-34	53	69.7	5,473	57.3	
	35-44	6	7.9	1,109	11.6	
Ethnicity	White	63	82.9	7,052	73.8	NS
	Black	1	1.3	124	1.30	
	Latino	10	13.2	1,910	20	
	Native American	1	1.3			
	Asian	1	1.3			
Annual Household Income	Less than \$50,000	26	35.1			
	More than \$50,000	48	63.2			
Education Level	≤ High School	16	22.5	1,281	13.4	NS
	> High School	55	77.5	8,098	84.7	NS

\*NS = non-significant

**Method of Data Collection.** The survey developed by the research team collected information regarding demographics (age, race, zip code, average annual household income, highest level of education); the child's age, weight, length, gestational age at delivery, prenatal genetic screening, family history of genetic disease, adverse birth outcomes; and delivery information (distance and time traveled for delivery, county of delivery, complications before, during and after delivery for child or mother, method of delivery, need for neonatal intensive care unit [NICU], and need for hospital transfer for either child or mother). The surveys were administered using REDCap®, and all survey data were stored on a secure server at the home institution. Most surveys were completed by entering data directly into REDCap®, however, a few paper surveys were completed, then entered into REDCap® by the STORM medical student and subsequently destroyed. These surveys and informed consent were made readily available in English and Spanish.

**Statistical Analysis.** Statistical analysis was performed on the respondents' quantitative and qualitative responses. The analysis team coded open text comments for positive, negative, and neutral replies. Additionally, a bivariate analysis of gestational age, birth weight, birth length, pregnancy complications, delivery complications, method of delivery, need for NICU, and need for hospital transfer for mother and/or neonate was performed. The responses to the survey were examined as a function of the self-reported distance (in miles) traveled by the mother from her residence to the hospital of delivery. Twenty miles was used as the distance cutoff for two reasons. First, 20 miles gave two cohorts that were of reasonable size for comparison. Secondly, a natural break point was observed by examining the data. Due to the small sample and clinical time restrictions because of COVID-19, a larger sample population that traveled a longer distance could not be captured.

The KDHE Department of Vital Statistics makes annual birth statistics available online. They report adverse birth outcomes as low birth

weight, very low birth weight, gestational age < 37 weeks, and death rate. Since our study utilized maternal recall data, a reasonable estimation of birth outcome could be determined by using gestational age at birth, birth length, and birth weight as recalled by the mother.

An attempt was made to provide a weighted quantification to the survey data by assigning a numerical value to answers provided based on the relative severity of the birth complications. One point was assigned if the respondent marked the presence of an adverse birth outcome, pregnancy complication, and/or delivery complication. Zero points were assigned if the method of delivery was a vaginal delivery (either spontaneous or vaginal birth after cesarean section), one point if it was an instrumental-assisted delivery (either forceps delivery or vacuum-assisted delivery), and two points if it was a Cesarean delivery. Zero points were assigned if the newborn stayed in the room with the mother or if he or she was taken to the regular nursery after delivery. Three points were assigned if the newborn went to the NICU in their hospital of delivery or four points if the newborn was transferred to a NICU in another hospital. Two-tailed t-tests were performed to determine if there was a statistical significance between the self-reported distance traveled for delivery versus the aforementioned variables. A p value of less than 0.05 was used to infer statistical significance.

To compare our birth outcome findings as a function of distance traveled to the hospital-specific data counties reported to the state of Kansas, the publicly available 2017 American Hospital Association/Kansas Hospital Survey was retrieved.<sup>8</sup> These data initially were divided based on PDPG (i.e., densely settled rural, rural, and frontier), then subdivided by whether the county contained at least one hospital that offered obstetrical services. The KDHE birth statistics KIC (Kansas Information for Communities) database was used to retrieve birth weight and gestational age data for each of these counties.<sup>9</sup> Birth length information was not available through the KDHE database.

Two-tailed t-tests were used to evaluate the birth weight (very low birth weight [< 1,500 grams], low birth weight [< 2,500 grams], normal

weight, high birth weight [ $\geq 4,000$  grams]) and gestational age (early pre-term less than 34 weeks, pre-term 34-36 weeks, early term 37-38 weeks, full-term 39-40 weeks, late term 41 weeks, post-term 42 weeks or longer) of newborns whose mothers' resided in counties that did not offer obstetrical services versus counties that did offer obstetrical services within the same PDPG.

### RESULTS

**Participants.** Eighty-five women from rural and frontier regions of Kansas consented to be surveyed. Of these, 76 women satisfied all eligibility requirements. Nine participants were ineligible because they either delivered out-of-state, delivered in a hospital located in an urban region, their child(ren) was not less than three years old at the time of survey completion, and/or their survey was left incomplete. Tables 1 and 2 contain a discrepancy in the total number of responses (N) for each data comparison because some respondents chose not to answer specific questions. Table 1 compared the demographics (age, ethnicity, and education level) of our survey population to the rural population at large (rural, densely settled rural, and frontier counties) using the data from KDHE to determine the generalizability of our sample population. After performing a t-test on our data to KDHE's data, no statistical differences were found in all three comparisons.

**Obstetrical Measures as a Function of Distance.** Table 2 shows an analysis of the gestational age, birth length, and birth weight of the participating newborns. The data were compared between those who traveled a distance less than and greater than 20 miles and between annual household incomes of less than and greater than \$50,000. As demonstrated by Table 2, no statistical significance was found when using a two-tailed t-test to analyze the gestational ages, lengths, and birth weights of infants born to mothers who traveled more than 20 miles to deliver compared to mothers who traveled less than 20 miles.

Data obtained from KDHE from 2019, which revealed that 2.3% of deliveries with very low birth weight were from mothers who resided in a densely settled county without birth facilities compared to the 1.1% of deliveries from counties that offered birth facilities ( $p < 0.001$ ). Table 3 shows analysis of data from KDHE. The total birth weight and gestational age for each county within the same PDPG were obtained, then these counties were separated between those that offered obstetrical services and those that did not. The averages were compared to determine if there was a statistically significant difference in birth weight and gestational age in babies whose mothers had to travel to a nearby county for obstetrical care versus those babies whose mothers did not. As illustrated in Table 3, no statistical significances were found in the birth weight or gestational age of newborns whose mothers resided in a rural county that did not offer obstetrical services versus those rural counties that did offer obstetrical services.

**Table 2. Analysis of distance versus different newborn parameters.**

Parameter	Category	Mean	Frequency	p Value	
Gestational Age (weeks)	Distance < 20 miles	38.9	48	NS*	
	Distance > 20 miles	38.6	22		
	Income < \$50,000	Income < \$50,000	38.0	21	0.04
		Income > \$50,000	39.1	48	
Length (cm)	Distance < 20 miles	50.3	44	NS	
	Distance > 20 miles	50.6	20		
	Income < \$50,000	Income < \$50,000	49.2	18	NS
		Income > \$50,000	50.8	44	
Birth weight (grams)	Distance < 20 miles	3359	48	NS	
	Distance > 20 miles	3204	22		
	Income < \$50,000	Income < \$50,000	3054	21	0.007
		Income > \$50,000	3401	48	

\*NS = no statistical significance

Thirty-five percent of babies born to mothers who lived in frontier counties that offered obstetrical services were born at an early term gestational age of 37-38 weeks compared to the 22% of babies whose mothers resided in a county without birth facilities ( $p = 0.005$ ). Moreover, 65% of newborns from frontier counties that do not offer obstetrical services were born full-term at 39-40 weeks versus 51% of babies from counties with birth facilities ( $p < 0.001$ ). Additionally, no significant differences were found in the number of obstetrical complications/outcomes reported by mothers who traveled less than or more than 20 miles to deliver. In this analysis, the total number of birth complications, birth outcomes, method of delivery, and usage of intensive care unit by mother or newborn were taken into account.

**Obstetrical Measures as a Function of Annual Household Income.** Using a two-tailed t-test, babies born to mothers with a family annual income of less than \$50,000 were found to weigh less at an average of 3054 grams compared to 3401 grams in babies born to mothers with an annual household income greater than \$50,000. As shown in Table 2, this was statistically significant ( $p < 0.007$ ). Moreover, infants born to mothers with an annual household income of less than \$50,000 had an average gestational age of 38 weeks compared to babies from families with an annual household income of greater than \$50,000 with an average gestational age of 39 weeks ( $p = 0.04$ ).

**Obstetrical Outcomes as a Function of Education Level.** No statistical significances were observed in gestational age, length, and birth weight of babies whose mothers received an education equal to or less than high school versus those mothers who received an education greater than high school.

**Table 3. Analysis of the 2019 data from the Kansas Department of Health and Environment (KDHE).**

Region	Parameter	p Value	Total # of Counties Reporting Data without Obstetric Services	Total # of Counties Reporting Data with Obstetric Services
<b>Densely Settled Rural (N = 19 Counties)</b>			2 (10.5%)	17 (89.5%)
	Very Low Birth Weight (< 1,500 grams)	< 0.001	2.3%	1.1%
	Low Birth Weight (< 2,500 grams)	NS*	6.1%	6.0%
	Normal Weight	NS	82.4%	84.4%
	High Birth Weight (≥ 4,000)	NS	9.1%	8.4%
	Early Pre-Term < 34 weeks	NS	3.5%	2.6%
	Pre-Term 34-36 weeks	NS	7.9%	7.1%
	Early Term 37-38 weeks	NS	31.2%	27.8%
	Full Term 39-40 weeks	NS	54.4%	59.5%
	Late Term 41 weeks	NS	2.7%	2.5%
	Post Term ≥ 42 weeks	NS	0.23%	0.24%
<b>Rural (N = 28 Counties)</b>			13 (46.4%)	15 (53.6%)
	Very Low Birth Weight (< 1,500 grams)	NS	1.3%	2.0%
	Low Birth Weight (< 2,500 grams)	NS	5.6%	5.9%
	Normal Weight	NS	85.1%	85.0%
	High Birth Weight (≥ 4,000 grams)	NS	8.0%	7.1%
	Early Pre-Term < 34 weeks	NS	2.3%	2.7%
	Pre-Term 34-36 weeks	NS	6.4%	8.1%
	Early Term 37-38 weeks	NS	27.3%	24.4%
	Full Term 39-40 weeks	NS	61.0%	61.3%
	Late Term 41 weeks	NS	2.8%	3.5%
	Post Term ≥ 42 weeks	NS	0	0.06%
<b>Frontier (N = 33 Counties)</b>			25 (75.8%)	8 (24.2%)
	Very Low Birth Weight (< 1,500 grams)	NS	1.3%	1.2%
	Low Birth Weight (< 2,500 grams)	NS	5.6%	5.5%
	Normal Weight	NS	86.0%	87.7%
	High Birth Weight (≥ 4,000 grams)	NS	7.1%	5.6%
	Early Pre-Term < 34 weeks	NS	2.5%	2.7%
	Pre-Term 34-36 weeks	NS	7.8%	9.1%
	Early Term 37-38 weeks	0.005	22.0%	34.8%
	Full Term 39-40 weeks	< 0.001	64.6%	51.4%
	Late Term 41 weeks	NS	3.0%	1.8%
	Post Term ≥ 42 weeks	NS	0.065%	0.27%

\*NS = no statistical significance

**DISCUSSION**

This study, similar to a study performed more than 30 years ago, explored the possible relationship between impaired access to local birth facilities and adverse birth outcomes.<sup>10</sup> In the prior study, they found that women who traveled longer distances for delivery experienced a greater number of birth-associated complications, and their newborns experienced a greater rate of premature births. Similarly, in a study published five years later, they found a negative correlation between the availability of maternal care services and infant mortality.<sup>5</sup> According to that study, the loss of an FM-Mat physician in rural Florida was predicted to be associated with an increase of infant mortality of 2.3%, and the loss of an OB-GYN was associated with a 9.6% increase in infant mortality. A more recent study also demonstrated an increase of perinatal mortality in newborns whose mothers traveled more than four hours to access obstetrical services, as well as an increase of NICU admissions in these newborns.<sup>11</sup> However, unlike the studies mentioned above, our study did not find a statistical difference in birth outcomes between women who travel more than or less than 20 miles, although intuitively we expected an association. Perhaps one of the reasons our study did not reveal a difference is because it did not have the power needed to be predictive. Another possibility is that due to sample bias from recall data there was some imprecision. To address this source of error, we could extract data from the birth certificates. However, this was beyond the means of this study group.

When the data were obtained from KHA and the KDHE and compared to our survey, counties without birth facilities had a higher percentage of very low birth weights when compared to counties that did have birth facilities available to their residents. This finding aligned with another study's finding which stated that women who traveled a greater distance to receive obstetrical facilities experienced fewer prenatal visits, and that these newborns experienced lower birth weights and gestational ages.<sup>12</sup> However, the KDHE did not report distance traveled nor the birth outcomes from one rurality to another. This was one of the reasons the influence that distance to access obstetric services can have on birth outcomes of newborns from rural and frontier Kansas was investigated. The distance traveled by mothers living in counties without birth facilities was significant and may have played a role in having babies with very low birth weight. Further study in this area is needed.

Additionally, the KDHE data suggested that women from densely settled counties without birth facilities may experience barriers that are contributing to the development of adverse birth outcomes and/or pregnancy complications among the women from these communities. These very low birth weights may be due to premature deliveries or intrauterine growth restrictions; however, the KDHE data did not find a significant difference between the number of premature babies from counties without birth facilities compared to those with birth facilities. Perhaps social risk factors such as malnutrition, low income, or inadequate prenatal care due to lack of transportation or medical

insurance coverage, may have been contributing factors that led to newborns having very low birth weights. Furthermore, these nutritional deficiencies may have been due to having insufficient funds or living in a region where food deserts existed. This could be another area for further research.

Lastly, our study revealed that on average, babies born to families with a lower annual household income weighed less than those from a greater annual household income. A potential source for this association may be due to a myriad of complex issues in the social determinants of health compared to those from more affluent backgrounds. While this study was not designed to examine this issue, it aligned with a previous finding that demonstrated an association with preterm birth and intrauterine growth restrictions and lower socioeconomic status.<sup>13</sup> Some of the contributing factors that have been associated were chronic stressors, higher rates of maternal smoking, nutritional deficiencies, financial instability, and an increased risk of genitourinary tract infections among these women. A companion study to ours is examining adequacy of prenatal care related to distance traveled. That study may reveal a more specific association.

Surprisingly, during our analysis we found counterintuitive findings and represent an area for further research. Contrary to our previously mentioned findings, using the KDHE data, a greater number of babies in counties with birth facilities were delivered at an earlier gestational age of 37-38 weeks when compared to frontier counties without birth facilities. Additionally, more newborns were born at full-term at 39-40 weeks in counties that did not offer birth facilities. These findings were counterintuitive to existing research, especially with our initial presumption that mothers with impaired access to obstetrical services have babies with either more birth complications or premature deliveries. A possible explanation to the latter finding was that perhaps community health resources play an important role to compensate for the lack of obstetrical services within these communities. However, the reason for this finding was not clear. More research should be performed and more efforts need to be made to reach out to women from counties without birth facilities. This will help to understand the negative effects that a continual decline and/or absence of OB-GYN and FM-Mat physicians have on the development and delivery of newborns.

Due to how critical and life changing the lack of obstetrical services can be to the health of mothers and newborns, many states have established plans to increase the safety of births in rural areas by ensuring that pregnant mothers are transferred or referred to adequate facilities that can provide them with the appropriate care at the time of delivery. In Kansas, initiatives have been discussed to alleviate the shortage of physicians who provide obstetrical services by establishing loan repayment programs to recruit and retain physicians in rural Kansas.<sup>6</sup> There also has been recent discussion in Kansas about other methods for increasing access to obstetrical care in frontier and rural areas of the state. As of 2020, there were more than twice as many family medicine residencies; 685 compared to the 284 OB-GYN residencies.<sup>14</sup> Due to the increasing number of family medicine residencies, more family medicine residents are being trained in obstetrical care.

**Limitations.** This study had several limitations. First, COVID-19 (Coronavirus Disease 2019) reduced the data collection timeframe to half due to safety concerns. Consequently, the sample size did not allow

this study to gain enough statistical power to make strong associations. Second, there was limited published research with similar demographics, especially in the state of Kansas, that explored the relationship of adverse birth outcomes as a function of the distance mothers must travel to gain access to birth facilities in rural regions. Third, the state-wide data recorded for vital statistics by the KDHE limited how their data could be manipulated to make associations with the data from our study. Lastly, our participants were not offered enticements for their participation, which could have encouraged more participation and increased our sample size.

**Implications for Future Research.** It is worthwhile for this study to be repeated at a larger scale and more in-depth analysis. As previously mentioned, the most recent studies on this topic, to the best of our knowledge, were conducted 10 and 30 years ago. The fact that there were no recent studies for such a critical topic as adverse birth outcomes due to limited access to obstetrical services calls for another look, as much has changed within the last 10 years. For example, it would be interesting to learn what kind of strategies or resources women use to compensate for the distance they have to travel to the nearest birth facilities, since our study did not observe a significant difference in adverse birth outcomes between those who travel more than or less than 20 miles. Perhaps a future study should subdivide those women who travel more than 20 miles by income to see if there is a significant difference in birth outcomes. Low-income women who must travel greater than 20 miles might be impacted more significantly, due to the financial burden the travel can place on them. Travel also may become a more considerable barrier in adverse weather conditions. Western Kansas can have significant winter weather events precluding travel, even with a well-maintained car.

Our study also found some counterintuitive findings, such as the greater number of full-term babies from counties with no birth facilities compared to those with birth facilities, which is also worth exploring further. This study serves as a pilot for future studies examining this critical health issue for rural residents.

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