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**ANTECEDENTS OF INFANT MORTALITY:  
AN ANALYSIS OF RISK FACTORS IN  
RURAL AND URBAN ARKANSAS**

**By Shannon M. Holman, Frank L. Farmer,  
Russell S. Kirby and Bruce L. Dixon**

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**ABSTRACT**

This research examines the relationship between social and biological characteristics of the infant and mother and the probability of infant survival through the first year of life. The research also includes a consideration of the influence of residence (rural vs. urban). Employing linked birth and death certificate data for Arkansas (1985-1989), a logit model was estimated to assess the impact of social and biological factors on the probability of survival. The results indicate that metropolitan residence is positively associated with infant survival, but only at a marginal significance level. Other notable results include the importance of prenatal care and a lack of significance of race when other factors are controlled.

**INTRODUCTION**

As evidenced by the continuing concern with the cost, effectiveness and inequitable access to health care resources, policy makers are faced with reordering health care priorities. For instance, issues such as women's health, infant mortality, AIDS, and minority health are gaining more prominence in research and policy arenas. Within this restructuring, infant mortality has become a focus of particular concern. Infant mortality is a stark indicator of the performance of a society that goes beyond the simple measurement of the survival of the individuals. It is an indicator of the commitment of a society to the general well-being of its citizenry as well as providing

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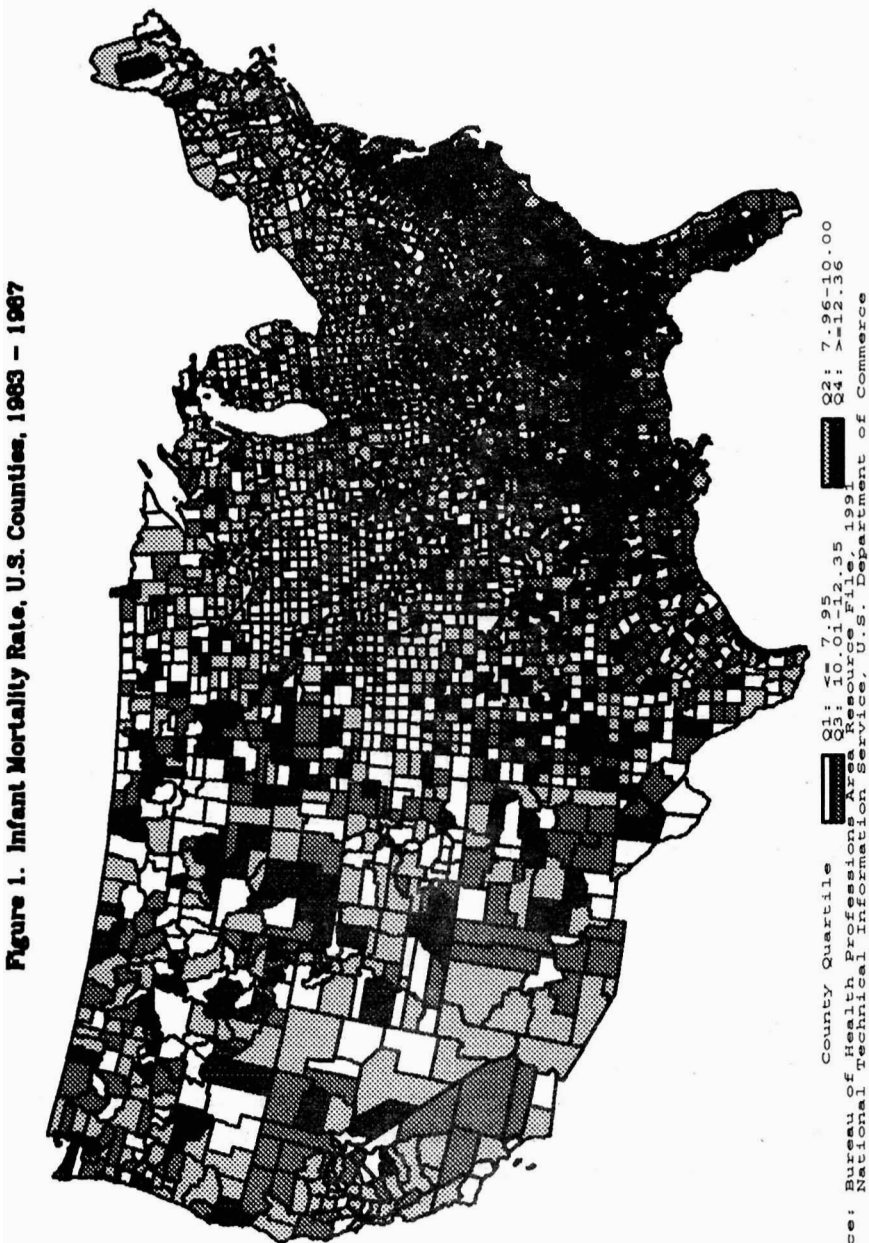
a measure of the relative deprivation of subgroups within a society. Indeed, differences in infant mortality between regions and population subgroups has often been used as a direct measure of the degree of stratification within a society.

The United States' poor performance in international ranking of infant mortality is a sad testament of the history of health care priorities as well as social and economic inequality in American society (Farmer et al., 1993; Farmer et al., 1991; Farmer et al., 1984; Pampel and Pillai, 1986). While infant mortality rates in the United States have declined since the 1960s, the decrease has not been as large as in other countries. For example, while the U.S. ranked 15th in 1968, by 1988 its ranking increased to 19th (National Commission to Prevent Infant Mortality, 1988).

Not only does the United States rank poorly internationally, but different geographic regions and social groups within the United States experience mortality levels that far exceed the national rate (Davidson and Fukushima, 1992; Farmer et al., 1993; Gortmaker, 1979). Information in Figure 1 shows the infant mortality rate by county across the United States for 1983-87. As shown, the South clearly experiences higher infant mortality rates than other parts of the nation. Although many counties outside the South exhibit high infant mortality rates, the map clearly illustrates the concentration of adverse pregnancy outcomes in the South.

While there is a clear concentration of higher infant mortality in the Southern region, this excessive mortality rate does not extend to all groups within the South. Specifically, blacks have an infant mortality rate far exceeding that of whites. Furthermore, as can be seen on the map, other areas with a high concentration of minority groups (American Indian and Hispanics) have relatively higher infant mortality. Information in Table 1 shows that at all levels of aggregation (state, regional or national), black rates are virtually double those of whites. Clearly, the high concentration of socially disadvantaged blacks in the Southern region assures a disproportionate contribution to the nation's infant mortality problem. The nation's overall high level of infant mortality (and the concentration of high rates within subregions) coupled with the fact that the U.S. spends more of its gross national product on health care, has generated an increased urgency for greater understanding of the antecedents of infant death (Marks et al., 1987; Pampel and Pillai, 1986). Therefore,

**Figure 1. Infant Mortality Rate By County in the United States, 1983-87.**



**Table 1. Infant mortality rates per 1,000 live births for the South and the nation, by color: 1987-89**

<b>Geographic Division and State</b>	<b>All Colors</b>	<b>White</b>	<b>Black</b>
Alabama	12.1	9.1	17.9
Arkansas	10.4	8.6	16.6
Florida	10.3	8.1	17.8
Georgia	12.5	9.4	18.5
Kentucky	9.9	9.2	16.7
Louisiana	11.4	8.4	16.1
Mississippi	12.5	9.0	16.4
North Carolina	11.9	9.1	18.8
South Carolina	12.6	9.4	17.9
Tennessee	11.1	8.5	19.2
Virginia	10.2	7.8	18.2
<b>Southern Region</b>	<b>11.3</b>	<b>8.8</b>	<b>17.6</b>
<b>United States</b>	<b>9.9</b>	<b>8.3</b>	<b>18.6</b>

Deaths are tabulated by race of descendent.

Live births are tabulated by race of mother.

Source: National Center for Health Statistics: Data computed by the Division of Analysis from data compiled by the Division of Vital Statistics in Health, United States, 1991.

data and analysis in the area of infant mortality are becoming increasingly important not only in the biological arena, but also in areas connected to the social and environmental context of pregnancy and child rearing.

## **PURPOSE**

The purpose of this research is to examine, in multivariate fashion, the relationship between the probability of survival through the first year of life and socioeconomic status and residence. More specifically, employing linked birth and death records for the state of Arkansas (1985-1989), the research examines the relationship between

social and biological characteristics of the mother and infant and the probability of survival. Among the variables considered are race, education, use of prenatal care, birth weight, birth interval and gender. There is also an explicit inclusion of the influence of residential location which considers both rural and urban areas. The inclusion of rural residence in the research is particularly germane because rural areas differ in meaningful ways along a number of socio-environmental parameters, and accordingly, health status indicators may also differ across rural communities<sup>1</sup> (Farmer et al., 1993).

The diversity in rural America in general and the rural South specifically, is, in many ways, mirrored by the state of Arkansas. Arkansas is very heterogeneous in terms of social organization, economic structure and physical environment. For example, the Mississippi Delta region of the state is characterized by a high proportion of blacks, extreme poverty rates, and an economy based on row crop agriculture. In contrast, the Ozark Highland region has a predominately white population and a more robust economy with a rapidly expanding poultry and tourism industry. Yet another distinct region, the Coastal Plain, has a high proportion of blacks, but a substantially lower poverty rate than the Delta. Major employers in this area include timber, oil and natural gas industries.

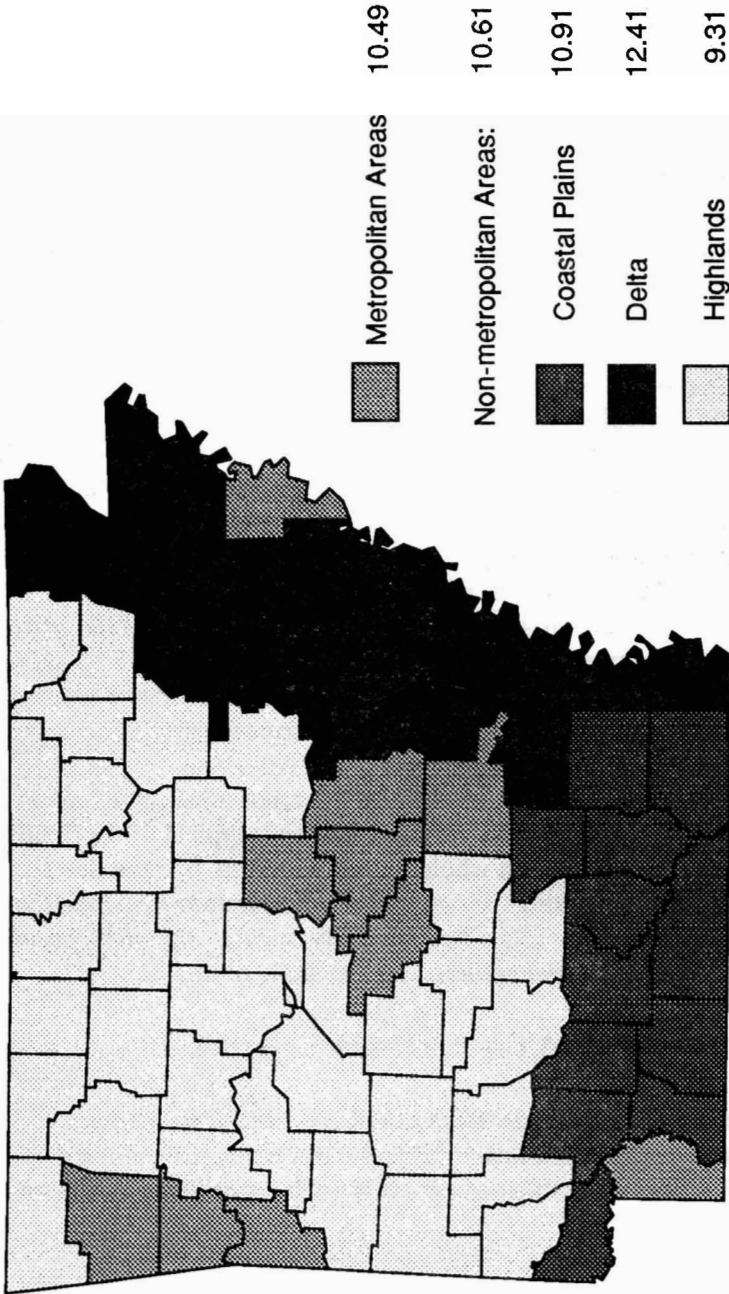
Arkansas has ten metropolitan counties with the full array of services and amenities inherent to areas of concentrated population. The 65 remaining nonmetropolitan counties are distributed among the three "rural" regions mentioned above. Based on the 1990 census, this categorization designates 59.9% of Arkansas' population as nonmetropolitan, ranking Arkansas as the ninth most rural state in the nation (Killian et al., 1993). Thus, Arkansas is typical of the Southern region and the nation as a whole in that within its borders lies a great diversity of rural settings as well as a concentration of population in metropolitan areas. This heterogeneity makes Arkansas an ideal laboratory for the social epidemiological study of infant mortality.

## DATA AND METHODS

For this analysis, data were gathered on characteristics of the infant and mother from linked birth and death records compiled by the state. Records were obtained for every birth occurring to Arkansas

Figure 2. Infant Mortality by Region: Arkansas, 1985-89

Figure 2. Infant Mortality by Region: Arkansas, 1985-89



Source: Arkansas Department of Health-Division of Vital Statistics

residents between 1985 and 1989 (n=175,223) from the Arkansas Department of Health-Division of Vital Statistics. Birth records were subsequently matched with infant death records to produce a linked birth/death file. The characteristics included in the analysis are mother's education, mother's race, number of prenatal visits, birth weight, birth interval and gender. Additionally, using address information from the birth records, mother's residence was assigned to regions within Arkansas.

The regional designation employed in the analysis is based primarily on the work of Fuguitt and Beale (1978). Their objective was to delineate homogeneous subregions in the United States which were based on economic activities, history, physical setting, settlement patterns and culture. As noted above, Arkansas has three distinct regions (Highland, Delta, and Coastal Plains). Further, in this research, the metropolitan counties are employed as a distinct category.

Logistic regression is used to relate the probability of an infant surviving the first year to the relevant independent variables. Logistic regression is an appropriate statistical technique to use with a discrete dependent variable and a mix of continuous and discrete independent variables. This approach allows simultaneous examination of the impact of a number of variables in order to estimate the effects of each while controlling for the others.<sup>2</sup>

## FINDINGS

The information in Table 2 shows the results of the estimated logistic regression model. Within the table, the odds ratio for the dichotomous independent variables is the ratio of the odds of survival when  $X=1$  to when  $X=0$ . The odds ratio for the continuous variables is interpreted as the change in the odds for an increase of one unit in the risk factor involved. For example, if the odds ratio is 2 when  $X=1$ , the odds of survival have doubled from when  $X=0$ .

As shown in Table 2, several variables are significantly related to an infant's chances of survival. Among those variables that may be categorized as biological determinants, low birth weight is clearly one of the major biological mechanisms through which physical and social



**Table 2 Logistic Regression Model of Infant Survival in Arkansas: 1985-1989**

Variable	Chi-Square	Odds Ratio	95% CL ***
Intercept	13.716 *	0.603	0.461 0.788
Birth interval <sup>^</sup>			
1 to 23 months	45.257 *	0.637	0.559 0.727
Birth weight in grams	2796.421 *	1.002	1.002 1.002
Gender <sup>^</sup>			
Male	33.670 *	0.713	0.636 0.799
Mother's education <sup>^</sup>			
Less than 9 years	4.894 *	0.752	0.584 0.968
9-12 years	1.469	0.915	0.792 1.057
Prenatal Visits	17.112 *	1.029	1.015 1.043
Mother's Race <sup>^</sup>			
White	2.604	0.896	0.784 1.024
Region <sup>^</sup>			
Metropolitan	3.243 **	1.145	0.988 1.327
Coastal Plains	0.748	0.910	0.735 1.126
Delta	0.131	0.969	0.820 1.147

\*  $p < .05$ ; \*\*  $p < .10$ <sup>^</sup> Binary and polytomous variables that exclude the referent variables.

\*\*\* Lower and upper 95% confidence limits on the odds ratio.

Source: Arkansas Department of Health-Division of Vital Statistics.

stresses operating in a society are expressed as elevated infant mortality rates (Newland, 1981). This finding is not surprising and further reinforces the importance of birth weight. As for the other biological variables, the odds ratio of less than one for males indicates that male infants are more likely to die than females, which is also consistent with past findings. The odds ratio of a birth interval (interval since the last pregnancy) between one month and 23 months is also less than one, indicating that infants born in this interval are more likely to die than are firstborns or infants born after a longer birth interval.<sup>3</sup>

When the socioeconomic variables are considered, a particularly compelling result is the lack of significance of the race coefficient. This model indicates that the mother's race does not significantly affect the probability of survival when controlling for other key variables. This result provides evidence that the observed higher infant mortality rate within the black population is a function of the higher degree of social and economic disadvantage experienced by this group (Antonovsky and Bernstein, 1977). Perhaps related to the lack of significance of race is the importance of the mother's education. As the model indicates, if the mother has less than nine years of school, there is a higher risk of infant mortality. This measure is a direct proxy of socioeconomic disadvantage and when controlled, likely explains the disappearance of the race effect.

Another indication of socioeconomic disadvantage is the use of prenatal care. Infant survival rate is significantly and positively related to the number of prenatal visits. A greater number of prenatal visits increases the survival rates for infants. The implication of this finding is that early and regular prenatal care can serve as a means of improving pregnancy outcomes. Furthermore, metropolitan residence appears to enhance the chances of infant survival, though the significance level of the coefficient is marginal ( $p < .10$ ). While this provides evidence of differences in pregnancy outcomes between metropolitan and nonmetropolitan areas, there are no significant differences among the Highland, Delta and Coastal Plains regions.

## DISCUSSION

The findings provide several insights into antecedents of infant mortality. The substantive implication of the findings is that in order to lower infant mortality rates, greater policy efforts are needed to address the social disadvantage and infant mortality relationship. The lack of significance of the mother's race when controlling for other variables is particularly germane given that the infant mortality rate for blacks is approximately twice that for whites. Clearly, increased infant survival rates for blacks will be associated with reductions in the social and economic inequalities existing in society.

One avenue for attenuating the impact of social disadvantage on infant survival rates is improved access to prenatal care. The

significance of prenatal care in the above model provides evidence of the importance of frequent use of such care during pregnancy. The provision of health and medical care in the first trimester can serve to identify high-risk pregnancies and ease entry into educational and support services for those in high-risk groups. The stress on preventative approaches through prenatal care rather than curative approaches to infant mortality is not only cost-effective, but also goes beyond the health of a single individual (Newland, 1981).

Given the low income levels of many women, more widespread insurance coverage is a necessary, although not sufficient, condition for meeting the health needs associated with pregnancy. For many women, the lack of health insurance represents an important factor limiting entry into care and removal of this barrier is crucial to improving infant mortality rates. However, while universal health insurance is necessary, other barriers to care must also be attenuated. These barriers include lack of availability of appropriate providers, lack of transportation and sociocultural obstacles (Farmer, 1992). A vital step in restructuring the health care system involves training and placing more family practitioners and health care providers in rural, underserved areas. Lack of transportation to rural health centers as well as urban health centers offering highly specialized care is also a significant barrier within the current health care system. Moreover, sociocultural barriers exist because of differences between receivers and givers of health care and often result in a mutual lack of understanding and trust. Sociocultural barriers also tend to be more prominent under conditions of poverty. Thus, to address the problem of lack of access to prenatal care, several issues must be addressed: (1) inequities in the current system of insurance must be eliminated, (2) more care givers must be trained and placed in underserved areas, and (3) access to transportation must be improved (Elders, 1992).

Another means of attenuating the social disadvantage and infant mortality relationship is more aggressive health education emphasizing proper nutrition as well as the dangers to the mother and infant of high-risk behaviors such as smoking and alcohol/substance abuse. It may be necessary to employ nontraditional educational approaches through churches, community development programs, primary and secondary schools as well as local health departments to reach out to disadvantaged individuals who are not as likely to be aware of the impact of prenatal behavior on pregnancy outcomes.

While increased efforts to educate women in the health arena is important, increasing the education level of the mother (in terms of the number of years of school completed) is imperative for attenuating the relationship between social disadvantage and infant mortality. Education captures a wide array of other elements of risk status. For instance, education serves as a proxy for such risk factors as poverty status, occupation, age and household structure. While data availability does not allow explicit consideration of all other elements associated with high-risk, the importance of education is a clear indicator of the impact of socioeconomic disadvantage on infant survival rates.

Although the evidence is marginal in terms of statistical significance, this research provides evidence of lower odds of infant survival in nonmetropolitan areas. The positive effect of metropolitan residence on survival is independent in that it is evident when other controls are included. Thus, after controlling factors such as race, education, and utilization of care, rurality appears to have an independent effect on infant mortality.

## FUTURE RESEARCH

While this research has identified some key relationships (some expected and some not), there issues surrounding the etiology of infant mortality remain unresolved. Several key issues have emerged from the social disadvantage and infant mortality relationship that need further analysis.

First, the interaction between the social and biological antecedents of infant mortality needs further investigation. For instance, questions remain concerning propinquity to prenatal care, utilization of care and pregnancy outcome. Furthermore, since the behavior of women plays a critical role in establishing and promoting a child's health, questions remain concerning attitudes of women toward health care and health care professionals along with other barriers that might impede knowledge in the area of health. According to the National Commission on Children (1991), the best way for a mother to protect her infant's health is by protecting her own health and being a role model for healthful behavior, by providing a safe home environment, and by seeking essential health services for her children. Therefore, a

major research effort is needed on how to stimulate responsible maternal behavior.

Further research is also needed on both structural and behavioral characteristics such as the role of the society as a whole and the individual communities in promoting the health of its citizens. The responsibility of the community lies in supporting the development of community-based health education and health care programs to help families gain access to needed services (National Commission on Children, 1991). Analyzing individual behavioral patterns as well as community development patterns in rural and urban areas is essential in attenuating the barriers to care. Policies that are intended to ameliorate infant mortality should focus on enhancing community development and local action in order to enhance the well-being of residents of local areas (Farmer, 1990). While federal and state policies and programs are necessary, the solutions often lie at the community level (Farmer, 1990).

Other barriers to care also need further investigation. For instance, research is needed to determine what socio-cultural barriers exist that deter women from accessing available health care. If a universal health care system is implemented in the United States, research will be needed on barriers such as transportation, access to health care providers, and incentives to increase personal responsibilities for prenatal care (Elders, 1992). Furthermore, a strong organizational structure is needed as well as increased cooperation from both the public and private sector. Healthful behavior and lifestyles are not enough to ensure optimal health. Without the support of both public and private sectors working together to increase accessibility to health care, many pregnant women will be at risk of poor birth outcomes.

The issue of race and adverse pregnancy outcomes also requires additional clarification. For example, the relationship among race, low birth weight and other social and biological variables needs further empirical articulation. Research is needed to address the gap between clinical research that has not focused on racial inequality, and population-based research which has not included clinical data (Davidson and Fukushima, 1992:1022). Furthermore, the interaction of rurality with race and other antecedents mentioned above also warrants further investigation. While the role of rurality remains largely ambiguous in the etiology of infant mortality, researchers

should be cognizant that nonmetropolitan residence may have an independent influence on pregnancy outcomes.

Further research is also needed to examine how the operationalization of the concept of "rural" effects the results of empirical examination of the residence and infant mortality relationship. Researchers and policy makers continue to employ different criterion for the conceptual and empirical tasks of establishing the boundaries and domains of the construct of "rural." Clearly, there is a need for renewed effort in the area of standardization of measurement of the concept that goes beyond classifying counties as either metropolitan or nonmetropolitan (Miller et al., in press).

A final area of research central to any restructuring within the health care system is cost. Specifically, fundamental analysis of the costs and benefits of more effective health care service delivery to rural populations should be undertaken. An example of such an analysis would be to estimate the savings to society of prevention of specific maladies common to rural people as opposed to the cost of this prevention. With the high cost of health care, many people cannot afford to obtain preventative care and therefore seek treatment only when their needs are critical. The results can be costly in terms of unnecessary medical problems and advanced conditions that are difficult and expensive to treat. Cost reduction through preventative care will continue to play an important role in the effectiveness of changes within the health care system.

Integral to changing the health care system is greater attention being focused on health outcome. Research is required which will provide insight into approaches to provide care that has positive health outcomes as the singular goal. The role of research is, in many ways, that of a "gate-keeper," in that the inclusion of outcomes in the formula for provision of care may eliminate unnecessary and costly procedures.

## Endnotes

**1** The importance of residence as a key parameter in the health policy arena is evidenced by the recent establishment of the Rural Health Caucus of the U.S. Congress. The Rural Health Caucus has introduced a number of health-related bills. Implicit in many of these bills is the assumption that there is a "rural America" that differs systematically from its urban counterpart (Farmer et al., 1993). However, there is no single rural America, but many rural Americas (Miller, Stokes and Clifford, 1987). Hence, implementation of one homogeneous, rural health policy may be ineffective or even detrimental to some rural communities.

**2** A larger number of variables were initially considered than are presented in this research. Other variables such as gestational age, maternal age and marital status of the mother were considered in preliminary models. However, gestational age was excluded because of a large number of missing observations and concerns about reliability. Maternal age and marital status were excluded because of collinearity problems and lack of significance as well as potential reliability problems.

**3** The referent variable for birth interval is 24 to 47 months and firstborn children. Preliminary analysis showed being a first born was not significantly different from being born more than 24 months after a mother's previous births.

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