The Implications of Death for the Future: Ecological Determinants of Infant Mortality in Louisiana

Shew-Jiuan Blanka Su*

National Kaohsiung Normal University, Taiwan

Death is not only a private event, but a matter of public domain. Infant mortality has long been recognized as a manifestation of socio-economic disease, particularly in the Third World. However, concern for infant mortality is not limited to the third world countries. Even within a country, there are often differences in infant mortality which can shed light for policy and development implications for governments. Based on socio-economic and health data at the parish level of Louisiana, the study analyzes the association of infant mortality and its ecological environment. Housing quality and income inequality are variables significant in determining Louisiana infant mortality. IMR difference may indicate the cause of tension among US populations and pressure among populations for resource distribution and redistribution.

Keywords: infant mortality, policy implication, development, the third world, socio-economic disease

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I. Introduction

Death is not only a private event, but a matter of public domain. Infant mortality has long been recognized as a manifestation of socio-economic disease, particularly in the Third World. However, concern for infant mortality is not limited to the third world countries. Even within a country, there are often differences in infant mortality which can shed light for policy and development implications for governments.

As a developed country, the U.S. has dropped its ranking of infant mortality rate (thereafter, IMR) from number eleven (26.0 per thousand births) in 1960 to number nineteen (9.9) in the world in 1988 (Nobile, 1990). In 1990, the average of U.S. IMR is 9.1 (PRB, 1991), which still ranks high among developed countries. Meanwhile, due to persistently dramatic socio-economic disparity, places with relatively low socio-economic attainment have suffered from higher infant mortality. Particularly alarming is the sensational difference in infant mortality between the black and white populations in the U.S. (Wise, Kotelchuck, Wilson & Mills, 1985; Brandt, 1984; Koontz, 1984; Shin, 1975). To reverse the racial phenomenon with appropriate policy, it is important to determine factors underpinning the high infant mortality of the Afro-Americans.

This paper sets out to identify the ecological determinants of Louisiana's infant mortality. Based on socio-economic and health data at the parish level, the study analyzes the association of infant mortality and its ecological environment. Multiple regression analysis is used to explore the relationship for the black, white, and total populations. Various models of population is used to identify IMR difference which is often the cause of tension among US populations and pressure among populations for resource distribution and redistribution.

Identification of determinants for infant mortality deserves careful attention, due to the generally recognized differently socio-economic and demographic factors for infant mortality in various

countries. For instance, housing quality and sanitation variables are usually emphasized for developing countries only. Being a part of the U.S., Louisiana, however, has a socio-economic predicament usually characterized by development economists as the third world in the U.S. Thus, a combination of variables for developed and developing countries is used.

Table 1 persents Louisiana's IMR of three population categories for 1988-1991. Not surprising is the general trend of declining infant mortality rates. However, the black IMR's are generally twice as high as the white IMR's in the late 1980s and early 1990s. The racial difference affirms the separate treatment of the determinants of IMR for both races. Furthermore, the 1990 IMR of Louisiana (11.04) is twenty percent higher than the U.S. national average (9.1). These facts warrant a study of the ecological determinants of infant mortality in Louisiana, so that policy measures for reduction of infant mortality at national or state level can be formulated.

II. Literature Review

The study of infant mortality can be approached from two dimensions. One is the individual (behavioral) or retrospective approach. This approach can be considered as the micro level. Generally speaking, this approach may provide a more direct cause and effect analysis of infant mortality. With the micro approach, biological aspects, such as mother's age, birth order, birth interval, and breast-feeding, can be well analyzed. Behavioral aspects, such as mother's education and gender of infant can also be addressed with the micro approach. Specific and micro insights may be raised through this approach. However, the approach is often limited by data availability and data quality. As Lantz et al. (1992) point out, retrospective data tend to possess "recall errors which result in the omission of events, the misplacement of dates, and the distortion of reports of duration" (1992, p.121) . The problem of data availability is another difficulty common in micro level study.

Aother approach focuses on ecological or macro measure. It

views an aggregate geography as an integral unit (in this case, parish), and assumes the equal exposure of every incidence (infant mortality) to the aggregate environment. Despite its not being explicit in treating individual data and information, the approach may provide an overview of the determinants of infant mortality. This approach leads to understand how a place's characteristics influence the incident of infant mortality. Moreover, planners may benefit more from such an approach for macro policy planning regarding socio-economic and ecological environment. These advantages justify the use of the macro approach in the present study, which seeks to identify the relationship between infant mortality and its ecological determinants.

Studies have identified the relationship between IMR and various socio-economic, health, biological, and behavioral factors. Factors proven to be important include race, place of residence, family income, father's occupation, housing quality, mother's education, access to sanitary water, breast-feeding, access to medical care, and physical environment. However, the significance of variables depends on the geographical scale, man-land relationship, ethnicity, timing of infant death, and degree of development of the place in question.

A word of caution needs to be addressed regarding the issue of threshold. Preston (1975) argued that for developed countries the economic determinants of infant mortality should take the issue of threshold into consideration. That is, beyond certain range economic and demographic variables will have little or no influence on infant mortality. If this is the case for income per capita variable, for example, the effect of income per capita, beyond certain level, may not be statistically significant.

Income as an indication of economic growth is the rule of thumb in orthodox approaches. However, it is too static and deterministic to serve as a sole indicator for infant mortality, although it lays out an approximate explanation. Lee's (1991) study of 1861-1971 infant mortality in Britain illustrated a wide spectrum of factors related to infant mortality. Significant variables included were income per capita, equality of income distribution, water supply, sewage disposal,

safer milk, and better food hygiene. Willie's (1959) study of Syracuse, New York found a rather strong inverse relationship between family income and the distribution of neonatal and post-neonatal mortality rates. Hojman's study (1989) also supported the negative association of average family earning with infant mortality in examining a 1978 Chilean case by using average family earning as an endogenous variable.

Housing quality variables related to infant mortality often include affordable energy for poor households and access to sanitary water. Hojman's (1989) study concluded that the withdrawal of subsidies for energy consumption of Chilean urban household, and the consequent increase of the price of butane/calor gas, contributed to infant mortality in the 1970s.

Sanitation of housing unit is usually a concern in the study of infant mortality of the Third World countries. DaVanzo's (1983) study of Malaysian households found that the improvement of sanitary water supply was significant to the decline of infant mortality. Meanwhile, the regional difference of infant mortality, she argued, was better explained by sanitary water supply than mother's educational level. Nonetheless, mother's education was found significant to the education of infant mortality (DaVanzo, 1988; Hobcraft et al., 1984; Cramer, 1987).

Breast-feeding is a conventional infant feeding practice, yet many mothers of urban areas forsake the practice. Therefore, breast-feeding becomes one of the factors underpinning the narrowing gap of IMR between urban and rural areas. In Kintner's (1988) historical study of infant mortality in Germany, breast-feeding explained the regional variation of IMR for 1871-1933. DaVanzo (1988) also argued that poorer states in Malaysia had a smaller decline of the practice of breast-feeding, which in turn contributed to a greater decline of infant mortality.

Health care delivery system is a long-term concern for demographic and public health planners. The deprived group of society is usually in need of more "equal access either to health care or to other amenities essential to the maintenance of good health" (Stock-

well et al., 1987). Kintner (1988) argued along the same line, although he found no evidence that advances in medical technology directly affected the level of infant mortality.

Urbanization, or place of residence, is another important aspect influencing infant mortality. According to infant mortality studies of Louisiana by Pieper (1974) and Kliebert et al. (1978), place of residence did play a role determining infant mortality at micro level. Daigle's (1978) study of Louisiana infant mortality showed the rural population (towns with less than 2,500 pelple) and the metropolitan areas with population over 100,000 had higher infant mortality. For many other studies of the Third World countries, urbanization or place of residence plays an important role in infant mortality (Ibrahim, 1983; Behm Rosas et al., 1987).

III. Data, Hypotheses and Methodology

The data sources for the present study are 1990 Census of Population and Housing (U.S. Bureau of Census, 1992), Public Health Statistics of the Department of Health and Hospitals of Louisiana, and Louisiana Hospital Society (1992). These data are utilized in two different types of multiple regression analysis for the black, white and total infant mortality.

Two types of model are ordinary least-squares regression, and weighted least-squares regression with income per capita as the weighing variable. The choice of variables is done through a preliminary quasi-stepwise backward selection strategy. The preliminary analysis finds that some conventionally important variables are not significant. Examples are education, persons per room, sewage disposal, and kitchen facility. These variables are then excluded from the study.

Infant mortality rate is defined by the number of deaths of infant under one year of age per thousand live births in a given year. The IMR of 1990 at the parish level of Louisiana for the black, white and total population serves as the dependent variable for the study. To eliminate data fluctuation and to level off measurement

errors, the 1990 IMR's are derived from the average infant death and births data for 1989, 1990 and 1991.

A total of seven explanatory variables are included. Per capita income used as weight for regression model; the rates of teenage births and housing units without complete plumbing facility are two independent variables broken down by race. The break-down data provide better estimates for the analysis. However other variables are not broken down due to data availability. All independent variables are derived from 1990 data. For ease of analysis and interpretation, the independent variables can be sub-divided into different categories: housing quality, health infrastructure, financial status, teenage births, and level of urbanization. The summary statistics of all explanatory variables are presented in Table 2.

The category of housing quality covers two variables: housing units without complete plumbing facility, and those without public water (clean water) provision. The variable of housing units without water provision indicates the housing units lacking public or private company water provision and with only drilled or dug well.

Health infrastructure is reflected by the numbers of hospital beds per 100,000 population. As this information is not available, data from 1992 are used as a proxy. The data are based on the number of licensed hospital beds in mid-1992 recorded by Louisiana Hospital society. Although there is a less than two percent increase of total hospital beds throughout the state, the paper does not take the distribution of the increased beds into consideration.

Variables in the financial status category include households receiving public assistance income and unemployment rate. The households receiving assistance income variable is the percentage of households receiving assistant income of any kind. The unemployment rate reflects the rate of population over sixteen years old and looking for jobs. The percentage of rural population is used as a reverse indication of urbanization. Teenage births variable is the percentage of total births by mothers under twenty years old (from 10 to 19) to total births of 1990.

Four hypotheses are tested. The first hypothesis is that infant

mortality is negatively associated with housing quality. The lower the housing quality is, the more is the incidence of infant mortality. Housing quality is reflected by water provision and complete plumbing in housing units. The second hypothesis is related to financial status. Two factors are chosen to reflect financial status: unemployment rate and receiving assistant income. It is hypothesized that the financial status has a positive relation to infant mortality. That is, the fewer households receiving assistance income or the lower unemployment rate in a parish, the lower is the infant mortality level. The third hypothesis assumes a negative association between infant mortality and health infrastructure. The larger the number of hospital beds, the lower the rate of infant mortality is in a parish. The final hypothesis is that high teenage births contribute to the incidence of infant mortality.

Ⅳ. Statistical Analysis

The two statistical models generally accent the significance of independent variables consistently (Table 3). The weighted models do not indicate a better statistical results in terms of better goodness of fit. Statistical results for both models of different populations are presented. Then the paper lays out a general analysis focusing on the important explanatory factors/variables and their implications for policy and development.

4.1 Models for Total Infant Mortality Population

For the total population, the ordinary least-squares and weighted least squares models show essentially the same results. Percentage of rural population, receiving assistance income and unemployment rate are significant at the 0.05 level of significance, and number of hospital beds is significant at 0.1 significance level.

The percentage of household receiving assistance income has a strong positive association with infant mortality. It indicates that the more households receiving assistance income in a parish, the higher the infant mortality is. However, the result on unemployment sug-

gests a negative relationship with IMR. Therefore, the hypothesis of financial status is basically rejected. The percentage of rural population has a significantly negative relationship with the total infant mortality. Thus, high percentage of rural population contributes to low total infant mortality. Residence hypothesis therefore is not supported. The number of hospital beds has a positive relationship with infant mortality. This implies that the more the hospital beds the higher the infant mortality rate is in a parish. This remains another dilemma in interpretation, other than the unemployment rate variable, although previous research once demonstrated bureaucratic inefficiency of medical care (Illich, 1976) .

4.2 Models for Black Infant Mortality Population

For the black infant mortality population models, the results of the statistical models are not as consistent as the models of the total infant mortality population. Number of hospital beds and households without complete plumbing are two variables without consistent result in two models. The former variable is only significant in weighted model at 0.1 level; the latter variable is significant in ordinary least square model at 0.1 level. The positive effect of hospital beds on infant mortality is contradictory to previous findings. The other housing quality variable-clean water provision, is significant in both models at the 0.05 significance level. Although such a result is presented, the housing quality hypothesis is not fully supported due to the rejection of the important of plumbing variable.

Percentage of population receiving assistance income is significantly associated with infant mortality at 0.05 level. The higher the proportion of population receiving assistance income, the higher the infant mortality is. Furthermore, unemployment rate is significant for both models, although its negative effect on infant mortality does not coincide with conventional results. Therefore, the financial status hypothesis is only supported as a determinant of the reduction of infant morality when receiving assistant income is considered. The percentage of teenage birth is not significant in either model. The teenage births hypothesis is thus rejected. The rural population vari-

able is negatively significant in both models. The place of residence hypothesis is thus rejected.

4.3 Models for White Infant Mortality Population

The models of the white infant mortality perform somewhat different from those of the black population. The percentage of rural population is not significant in either model. The variable of teenage births is only positively significant for the ordinary least square model at 0.1 level. This result differs from that of the black population.

Both of the financial variables are positively significant. The unemployment rate variable is significant at the 0.05 level, and receiving assistance income variable at the 0.1 level. The hypothesis of financial status is thus supported.

The results on the housing quality indicate that only the plumbing variable is positively significant at the 0.05 level. Because clean water provision variable is not significant, the housing quality hypothesis is not supported. Finally, the variable of hospital beds does not show a significant effect on infant mortality in either model.

4.4 Contextual Analysis of Results and Implication for Policy and Development

The statistical results of all the models have sorted out both a general consensus and a racial differential for the determinant of infant mortality in Louisiana. The consensus is in variables of financial status. The differences are shown in variables of rural population and clean water provision for the black and white infant mortality.

Households receiving assistance income is a consistent factor associated with the black and white, and total infant mortality population. It can be viewed as the most important determinant in Louisiana's infant mortality. To reduce the level of infant mortality, the reduction of households receiving assistance income can play a meaningful role. Macro socio-economic policy for improving the

socio-economic status of poor Louisianans and thus for reducing infant mortality should focus on the increase of household income, that is evidently associated with receiving public assistance. This measure coincides very much with what Clinton's government is doing about reducing under-employment or unemployment and raise labor participation of the America. The reduction of under-employment may be a channel in this regard. However, this is not to be confused with unemployment rate variable, because there is a contradictory result showing a negative relationship between IMR and unemployment rate. The negative relationship needs to be explored further.

There are three differentials shown in the regression results of the black and white models. First is the percentage of rural population. For the black infant mortality, urbanization plays an important role. The higher the percentage or rural population, the lower the infant mortality is. This result, contradictory to most other studies, e.g., Pieper (1974), Kliebert et al. (1978) and Daigle (1978), may be, on the one hand, explained by the issue of threshold. On the other hand, infant mortality is more likely to be higher in metropolitan or hugh urban areas where the black population is more likely to be in poverty and unemployed, and to be without kin help. Almost two decades ago, the infant mortality of Louisiana was positively determinated by the level of rural residence (Daigle 1978), but today the phenomenon is reversed and more urbanized places may find higher infant mortality rate. This may explain why higher percentage of income assistance from the federal government goes to the urban poor in the U.S.

The second difference between the black and white infant mortality population is reflected in the variable of housing without clean water provision, and the third reflected in housing units without complete plumbing facility. The more housing units without clean water provision, the higher the black infant mortality rate is. However, the white infant population is easily affected by the lack of plumbing facility. This may shed light for government planners who are interested in reducing infant mortality. By making clean water

provision for rural poor, governments may expect to see lower rate of black infant mortality. In particular for Louisiana's rural poor, cancer alley which denotes chemical or other contamination around the alluvia plain of Mississippi River is often considered something of first priority. By providing adequate housing facility like plumbing equipment, white infant mortality may be expected to improve over time. Such policy implication drawn from infant mortality certainly warrants some attention from various U.S. governments.

The number of hospital beds plays a role in determining the infant mortality of Louisiana; yet, the effect of this variable is positive. This phenomenon can result from the fact that the parish with more hospital beds is often the place where more poor population, who are lack of access to hospital facility, congregate. The problem may lie in the predicament with the delivery system of medical facility in Louisiana's parishes. Illich's (1976) assertion of inefficiency of bureaucratic medical system may explain such a dilemma. And it would be misleading to conclude that hospital beds leads to infant mortality. Teenage births seem not to be a factor influencing infant mortality. The results of most models reject the hypothesis for teenage birth's detemining power on infant mortality, but it would be beneficial to take the issue of teenage pregnancy and birth into consideration for planning a healthy future of the U.S..

The statistical results suggest two major dilemmas, including the number of hospital beds, unemployment rate and residence variables. Theories and convention suggest that the more hospital beds will decrease infant mortality. However; this is not suggested by the present analysis. This finding is not new in the studies of infant mortality in developed countries (Fuchs, 1974; Miller and Stockes, 1978). Two explanations may be applicable. One may relate to the quality of health and medical care system-hospital beds. Without improvement of quality of personnel and services of health and medical care, the number of hospital beds guarantees no reduction of infant mortality. The other aspect relates to the health care delivery system, i.e. the accessibility to health facility. If the accessibility to health and medical care can not be immediate or improved for the needy,

the increase of number of facility alone will not guarantee a reduction of infant mortality. The other dilemma is reflected in the negative effect of unemployment rate on infant mortality. Even if there is a threshold for the association between unemployment and infant mortality, the result warrants some further investigation. The dilemma of place of residence variable needs further investigation as well.

The macro study of infant mortality may not provide retrospective details, but it is worth the attention of demographic, public health and socio-economic planners in the effort to reduce infant mortality. Sensible macro or micro programs for the reduction of infant mortality, which may have further socially and even politically relevant implications for the society as a whole, are most needed for the U.S. government which is interested in promoting regional equality.

V. Discussion and Conclusion

The factors affecting infant mortality are by no means easy to conclude. The present study is limited in its scope, and some other important issues need to be addressed further.

First, the limitation shows in its ecological approach. For a direct and close analysis of causal relationship between socio-economic status and infant mortality, a study of retrospective or micro level may also be appropriate. However, due to the limitation that may hinge in a micro level study, a strategy of combining the merits of micro and macro levels may be worth pursuing. Secondly, a smaller geographical level, rather than a parish, can be used for a better monitoring of the micro relationship of socio-economic status and infant mortality, although data at such micro level may not be available. Third, the generally low coefficient of determination (r^2) for all the models suggests that additional relevant factors are to be included and explored. Examples include the break-downs of the explanatory variables used above, and income inequality or equality variable. Finally, for a more detailed and contextual understanding

of the infant mortality in Louisiana, the spatial differentials of infant mortality and existing policy related to infants should be studied.

Different scales of geography may result in different results of studies, since the agglomeration of data may eliminate some characteristics of data. Therefore, even if the result of the study replicates that of other larger scale or smaller scale studies, the application of such result will need cautions. However, if inferential mechanism is made to deduce for some other places, there is always caution to be taken.

For a state like Louisiana with a high proportion of low income population and a high proportion of Afro-American population, the socio-economic policy planners should make special efforts to meet the need of the poor and the deprived. In particular, the differences between the black and white populations should be taken seriously for the betterment of the disadvantaged, and the equality and unity of the society. Since IMR is a sensible indicator for the development of a society. A contextual understanding and socially relevant concerns and policies for infant mortality will be for the betterment of society as a whole.

Table 1. Infant Mortality Rates of Louisiana (per thousand)

year	1988	1989	1990	1991
Black	14.23	16.09	16.67	13.78
White	8.88	8.47	7.14	7.83
Total	10.94	11.48	11.04	10.27

Source: Public Health Statistics, Department of Health and Hospitals, New Orleans, Louisiana.

Table 2. Summary Statistics of All Variables for 1990 Study of Infant Mortality, Louisiana

Variable	Mean	Std. Dev.	Minimum	Maximum
IMR*				
White	8.115	3.679	0.000	19.680
Black	13.798	5.775	0.000	26.860
Total	10.757	3.366	3.828	21.540
Rural population %	0.576	0.283	0.403E-03	1.000
Receiving asst. income	0.133	0.047	0.057	0.304
Percentage of teenage births				
White	0.154	0.052	0.021	0.367
Black	0.239	0.059	0.000	0.359
Total	0.191	0.045	0.120	0.360
Hosp. beds per 100,000	554.200	849.140	0.000	4767.000
No clean water provision	0.153	0.149	0.001	0.620
Per capita income (in $1,000)				
White	11.139	2.126	8.131	20.180
Black	4.890	1.004	2.966	7.477
Total	9.075	1.629	6.059	13.600
No complete plumbing				
White	0.007	0.005	0.000	0.286
Black	0.038	0.025	0.000	0.103
Total	0.022	0.015	0.341E-02	0.628
Unemployment rate	0.106	0.026	0.066	0.240

Source: Summary Tape File 3A and 1A, and Country Statistics File 4, U.S. Bureau of the Census (1992); Public Health Statistics, Department of Health and Hospitals, Louisiana; Research Data Department, Louisiana Hospital Society, Baton Rouge, Louisiana.

*indicates the rates are retained from three years average, 1989, 1990 and 1991.

Table 3. Regression results of various models for black, white, and total infant mortality in Louisiana

	Black		White		Total	
Models	OLS	Weighted	OLS	Weighted	OLS	Weighted
Variables						
Constant	17.810**	15.792**	8.999**	9.050**	9.299**	8.374**
	(3.953)	(3.898)	(2.081)	(2.029)	(2.068)	(2.009)
Rural popula-	-12.501**	-12.729**	-1.962	-2.484	-3.732**	-3.824**
tion %	(3.145)	(2.928)	(2.087)	(2.081)	(1.857)	(1.738)
Receiving	97.221**	92.960**	37.804*	37.369*	58.738**	55.679**
Asst. income	(29.560)	(29.750)	(19.880)	(20.820)	(17.280)	(17.070)
Percentage of	-10.545	-7.615	19.012*	15.689	9.862	10.895
Teenage births	(12.230)	(11.560)	(10.480)	(10.480)	(11.380)	(11.120)
Hospital beds	1.188	1.252*	0.047	0.074	0.781*	0.800*
Per 100,000(10^{-3})	(0.755)	(0.747)	(0.508)	(0.511)	(0.446)	(0.446)
No clean water	11.826**	12.555**	-1.059	-1.061	3.360	2.990
Provision	(4.768)	(4.624)	(3.285)	(3.387)	(2.809)	(2.689)
No complete	58.037*	50.118	304.740**	329.190**	57.703	50.426
Plumbing	(32.820)	(31.730)	(102.200)	(105.000)	(36.350)	(35.290)
Unemployment	-112.470**	-91.812*	-90.924**	-84.687**	-78.436**	-65.081**
Rate	(49.130)	(50.960)	(36.320)	(37.170)	(31.490)	(31.740)
R^2	0.314	0.345	0.236	0.221	0.296	0.313
Adj. R^2	0.228	0.263	0.140	0.123	0.208	0.227
F	3.659	4.140	2.469	2.226	3.361	3.643

Standard errors in parentheses. Asterisks indicate levels of significance: **=0.05 and *=0.1. Per capita income is used as weight for models with weighted least squares.

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