SOCIO-ECONOMIC DETERMINANTS OF INFANT MORTALITY: A PRELIMINARY INVESTIGATION

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I. Introduction

In recent years infant mortality has been the subject of increasing concern, perhaps for two related reasons. First, the overall decline of infant mortality in the United States has slackened, even though regional differences in rates persist.[1] Secondly, our infant mortality experience, and even that of areas with the lowest rates compares unfavorably with the experience of other developed nations (6,8,15); for, as Table I demonstrates, several European nations have rates lower than Utah, the state with the lowest infant mortality rates in the United States.

Table I

Infant Deaths Per 1,000 Live Births, 1967[2]

United States	22.4
Utah	16.6
Denmark	15.8
Finland	14.8
Netherlands	13.4
Sweden	12.9
Norway	12.8

For planning purposes and policy decisions, information relating to the characteristics closely associated with the infant mortality experience for areas is needed, i.e., what characteristics do areas with high infant mortality have? Such information on areas would seem to have more value for policy decisions and resource allocation than identifying such charactistics for individuals.[3]

As a step in this direction, this paper presents some preliminary analysis of infant mortality rates that exist among areas in one region of the United States. We plan to expand the study to the country as a whole using 1970, as the data becomes available. But for this preliminary study we restricted our analysis to the southeastern portion of the country, because it is one of the areas with the highest overall rates and because in this region great variation exists among localities with respect to infant mortality, income levels, and other variables.

II. Methodology and Data

The study employs multivariate regression analysis of cross-section data to investigate which characteristics of local areas are most closely related to the area's level of infant mortality.

The sample utilized in our analysis consisted of 1960 data for 551 counties in eight southeastern states.[4] This represents approximately 75 percent of the 734 counties in this region. The remainder were excluded either because complete data series could not be obtained or because their population was less than 10,000 people. This minimum population figure was required in order to prevent rather small absolute changes in the number of infant deaths from causing major fluctuations in mortality rates.

In addition to the infant mortality measures, nine explanatory measures were included in the analysis. The specific variables utilized are listed in Table II.

Table II

PBHOS = Infants born in hospitals/total infants born

IMR = Infants mortality/total infants born

NNMR = Neonatal mortality/total infants born

PNW = Percent non-white

PPOOR = Percent of Families with income below $3,000

FR = Children under five per 100 women 15 to 49 years of age

POPHSD = Population per household

BEDR = Short term general hospital beds/ population

PCPR = Physicians who's primary duty is patient care/population

PNNR = Post Neonatal mortality/total infants born

PURB = Percent of population in urban areas

Data relating to the various infant mortality measures was collected from the 1960 edition of Vital Statistics (19). The population and socio-economic variables were compiled from the 1960 census (18).

In some discussion of the problem of infant mortality, the supply of doctors and of hospital facilities are mentioned as one important determinant of the level of infant mortality (3,6,8,15). In order to test this hypothesis our study explicitly includes variables relating to the supply of health resources (in the form of the non-federal physician rate and the hospital bed rate).[5] The data on non-federal short-term general hospitals was compiled by us from American Hospital Association sources (1). The physician data was collected from American Medical Association sources (2) and unlike the remainder of the data series it refers to 1963, since this was the earliest year for which the data was available.

The investigation of whether such supply variables are closely related to infant mortality is also important because infant mortality is often used as a summary index of the quality of medical care received by inhabitants of an area (4, p.559).

Since the causes of infant mortality have generally been found to vary systematically with age (11,14,15), this study has disaggregated the infant mortality statistics into two subclasses, neonatal mortality (deaths occurring during the first month) and post-neonatal mortality (those deaths which occur during the remainder of the first year of life) to study whether the strength of relationships between the two segments of infant mortality and the explanatory variables are substantially different.

III. Results and Interpretation

Initially, several interesting points can be made of the simple correlations presented in Table III. For example, the supply variables, bed rate and physician rate are not highly correlated with the percent of infants born in hospitals, while the percent nonwhite and the percent poor are, in fact, the explanatory variables which are most closely correlated (in both cases a negative relation was indicated) with use of hospitals. Several possible explanations might be advanced for these results. First poor, and particularly nonwhite poor, individuals may be excluded from hospital facilities, due to either racial discrimination or to lack of wealth. Alternately, the explanation may be cultural, i.e., these groups may prefer to have their children at home. It is also possible that transportation costs and/or differential automobile ownership contribute to this pattern.

The socio-economic variables are found to be more highly correlated with post-neonatal mortality than with neonatal deaths. These findings tend to support the evidence from previous empirical studies, which utilized death records.[6] In a like manner, the correlation between the supply variables and neonatal mortality was found to be much weaker than the relation between these supply measures and post-neonatal mortality. Such results can most probably be attributed to the previously mentioned tendency for different causes of death at different ages. Neonatal deaths are usually due to immaturity or congenital malformations, while infectious diseases (which are more amenable to medical care) cause a high proportion of post-neonatal deaths (11,14,15).

Table III

Simple Correlation Matrix

IMR	1.000000										
PNW	.4865077	1.000000									
PPOOR	.3227890	.3593604	1.000000								
PBHOS	.4528181	-.7504172	-.5954418	1.000000							
BRDR	-.06011388	.04585699	-.1344326	.05504764	1.000000						
PURB	-.09191584	.02671853	-.6230910	.2231697	.2451806	1.000000					
POPHSD	.2802555	.4517182	.3745008	-.4888915	-.1643905	-.3340864	1.000000				
POPR	-.1210380	-.08241280	-.4435359	.2614871	.3634300	.5362321	-.3431448	1.000000			
FR	.3437361	.6395716	.3029297	-.5876336	-.1166915	-.1342311	.5943598	-.2737308	1.000000		
NNMR	.7959253	.2256201	.1511545	-.2196922	.004495067	-.02931197	.1067010	.01463263	.1670217	1.000000	
PNNR	.7604760	.5433187	.3589164	-.4952951	-.1018580	-.1169306	.3379406	-.1796855	.3757098	.2121593	1.000000

The regression results are presented in Table IV. The estimated t-values for the regression coefficients were utilized to test the significance of the relations between the dependent and the explanatory variables. The figures in parentheses directly beneath each estimated regression coefficient is its estimated standard error. Those cases in which the relation was indicated to be statistically significant are designated by asterisks, with one, two, or three asterisks signifying respectively the 0.10, 0.05, and 0.01 level of significance.

Table IV

Regression Results

	R^2	d.f.
PBHOS = 1.43053 - .00439139PNW*** - .005123589 PPOOR - .002257438 FR*** - .02892547 POPHSD* - .0003337689 PURB (.0003155885) (.0034848296) (.0007366395) (.01658236) (.0002917778) +12.82410 PCPR + .5455547BEDR (14.95495) (1.623369)	.6986443	543
PBHOS = 1.419589 - .00479845 PNW*** - .004912236 PPOOR*** - .002367216 FR*** - .02704132 POPHSD* (.0002856565) (.0003638259) (.0007222757) (.01592381)	.6976261	546
IMR = .02514097 + .0001990799 PNW*** + .0001227387 PPOOR** - .005737891 PBHOS - .2296512 BEDR + .00001153091 PURB (.00003612912) (.00005122902) (.004129646) (.1562339) (.00002811173) + .0006227159 POPHSD + .4097812 PCPR + .000009102862 FR (.001600193) (1.440096) (.00007149755)	.2686925	542
IMR = .02100154 + .0002382151 PNW*** +.0001462724 PPOOR*** (.00002202075) (.00003386011)	.2618274	548
NNMR = .02000289 + .00004571283 PNW* - .003189529 PBHOS + .00004791284 PPOOR + 1.137347 PCPR + .00004232896 FR (.00002719337) (.003108269) (.00003855864) (1.083920) (.00005381420) - .0005818479 POPHSD - .01613419 BEDR + .000001984518 PURB (.001204420) (.1175928) (.00002115891)	.06172415	542
NNMR = .0241644 + .00005174459 PNW** - .004729550 PBHOS* (.00002335400) (.002574220)	.05671490	548
PNNR = .005138086 + .0001533671 PNW*** + .00007482593 PPOOR** - .2135170 BEDR** + .001204563 POPHSD - .002548363 PBHOS (.00002125062) (.00003013216) (.09189448) (.0009412104) (.002428997) - .00003322610 FR - .7275664 PCPR + .000009546398 PURB (.00004205382) (.8470435) (.000016534491)	.3407515	542
PNNR = .004516408 + .0001688288 PNW*** + .00009087789 PPOOR*** - .2458189 BEDR*** (.00001301855) (.00002018004) (.08579566)	.3359214	547

Since the percent of infants born in hospitals varied substantially among localities and is commonly used as a measure of medical services in an area, we treated this variable as a dependent as well as an independent variable in the regression analysis. The only variables which were found to be statistically significant at the 0.10 level or better were socio-economic measures. The hypothesis that the supply of either medical services or hospital facilities affect the percent of infants born in hospitals must be rejected on the basis of these results, since the regression coefficients of both the physician rate and the bed rate were smaller than their standard error. The coefficient of determination, R^2, was approximately .70, which may be interpreted as the percentage of the total variance in the percent born in hospitals which was explained by the variables included in the regression equation.

In the regressions relating to total infant mortality, none of the supply variables proved to be significant. Both the percent nonwhite and the percent poor were found to be significant at the 0.01 level.

The separate analysis of neonatal and post-neonatal mortality did produce substantially different results. The regression equations for neonatal mortality demonstrated that differences in socio-economic and/or health supply factors could explain little of the variance in neonatal mortality rates (R^2 = 0.06). However, the relation between neonatal mortality and two variables, the percent nonwhite and the percent of infants born in hospitals, was found to be statistically significant. This tends to support the previous findings (7,16,22) of little correlation between socio-economic status and neonatal mortality and at the same time the existence of racial differentials in neonatal mortality (11, 14,15,22). The failure of either socioeconomic or supply variables to adequately explain the pattern of neonatal mortality is not surprising in view of the predominance of such deaths due to congenital malformations and immaturity, neither of which are directly measured by our variables.

In the post-neonatal mortality equations

on the other hand, the regression coefficients for the percent nonwhite, the percent of families with income of less than $3,000, and the bed rate were found to be statistically significant at the 0.01 level. Furthermore, the coefficient of determination indicated that these socioeconomic and supply variables explained approximately 34 percent of the total variance in post-neonatal mortality--quite a difference in explanatory power when compared with the low R^2 of the neonatal equations.[7]

While the availability of hospital services, as measured by the bed rate, was indicated to be significantly related to post-neonatal mortality, the regression results did not indicate a significant correlation between the physician supply and the level of post-neonatal mortality.

IV. Conclusion

This preliminary study has emphasized some interesting facets of the infant mortality experience as well as the need for further research. The difference between the ability to explain post-neonatal and neonatal mortality by means of socio-economic and health supply variables was striking. Our preliminary results also lend little support to the argument that high infant mortality rates reflect a "shortage" of medical and hospital resources.

Further extension of this study will allow us to test additional hypotheses, concerning the impact of maternal health programs, and the disaggregation of physician data by race will permit examination of the effect of physician race on racial mortality differentials. Another possible extension, if unpublished data is made available, will be to test the significance of variations in average birth-weight by county, since low birthweight is generally considered to be highly correlated with the probability of infant death. With the expansion of the study to national dimensions, we also hope to study the regions of the country separately in order to investigate whether substantial differences between regions exist.

FOOTNOTES

[1] For a discussion of the change in the trend see Moriyama (13). For a summary of the differences among regions in infant mortality see Moriyama (12) and Hunt (10).

[2] The infant mortality figures for the United States and for European nations were collected from the 1967 edition of Vital Statistics of the U. S. (20, pp. 2-6). U. N. Statistical Yearbook (17, p. 100).

[3] This need for planning and for implementation is emphasized by Hunt (10, p. 11) in a previous study in which those counties throughout the United States with excess infant mortality were identified. Further, using census tract data for the Chicago and Washington, D.C. metropolitan areas, this study also analysed the relationship between poverty areas and the level of infant mortality and found substantial poverty-nonpoverty differentials. Most other studies of the correlates of infant mortality, such as (5, 7,9,16,21) have utilized individual death records, rather than studying the relation between area characteristics and the area's infant mortality experience.

[4] Alabama, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee.

[5] At an earlier stage in the analysis, we tried to employ a binary variable in order to indicate whether or not a hospital was present in the county as an alternative measure of the supply of hospital facilities, but it was not found to be significant in any equation.

[6] In a Providence, R. I. study, Stockwell (16) found no relationship between neonatal mortality and a measure of socioeconomic status, while post-neonatal mortality and socioeconomic status were indicated to be significantly correlated. In a similar Boston study, Donabedian, et.al., (7,p. 1089) also concluded that neonatal mortality is much less sensitive to socioeconomic differentials than post-neonatal mortality.

[7] As mentioned previously in the discussion of the correlation matrix results, the evidence from the regression analysis supports previous findings that post-neonatal mortality is more sensitive than neonatal mortality to differences in socioeconomic status and other institutional factors (7,11,14,15,16).

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