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Economic Status Differences in Infant Mortality by Cause of Death

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Synopsis

Infant mortality differentials in a metropolitan aggregate of eight Ohio cities were examined for the years 1979-81. The primary analytical unit was the census tract of mother's usual residence. The independent variable was defined as the percentage of low-income families in each tract at the 1980 census.

Results of the analysis revealed that in spite of some very substantial declines in the overall level of infant mortality in recent decades, there continues to be a pronounced inverse association between the aggregate economic status of an area and the probability that a newborn infant will not survive the first year of life. This inverse association characterizes both males and females, whites as well as nonwhites, and it is observed during both the neonatal and postneonatal age intervals. Moreover, it is apparent that the adverse influence of a low economic status is reflected in the incidence of mortality from all major exogenous and endogenous causes. Since these two cause groups have such different underlying determinants, this finding has important implications for the development and implementation of specific maternal and child health care policies and programs.

ONE OF THE TRULY OUTSTANDING achievements of the 20th century has been the remarkable progress that has been made in reducing death rates. This progress has been most keenly reflected in a profound reduction in the risk of dying during infancy. At the same time, however, all of the available evidence makes it abundantly clear that the fruits of this progress are not being shared equally by all segments of the population. Rather, the findings of a wide variety of studies dealing with this decrease in mortality have consistently shown that the lower income groups in all societies

Table 1. Family income tertiles for census tracts in 8-city aggregate, Ohio, 1980

Income tertiles	Families with annual income less than $10,000	Number of census tracts
I High status	Less than 20.4 percent	237
II Medium status	20.4–37.5 percent	232
III Low status	37.6 percent or more	239
Total tracts		708

Table 2. Infant mortality rates for income areas, metropolitan Ohio, 1980

Income areas	Infant mortality rates		
	Total	Neonatal	Postneonatal
All areas	16.6	10.6	6.0
I High	11.3	7.6	3.7
II Medium	16.5	10.8	5.7
III Low	22.4	13.5	8.9

have been and continue to be characterized by an extremely pronounced disadvantage when it comes to the probability that a newborn infant will survive to adulthood. In the United States, for example, the existence of a general inverse association between infant mortality and socioeconomic status has been documented by studies based on individual level data (*1–7*) as well as by studies using the more common ecological approach (*8–14*).

The existence of such a situation in the United States, where we idealize the concept of equality of opportunity for all our citizens, represents a fundamental inequality that should be of serious concern to all. Research that contributes to a better understanding of the nature and causes of this situation is an essential prerequisite to designing and implementing those maternal and child health care programs that are needed to ameliorate this income differential and achieve more equitable chances for a long life for all Americans. It is hoped that this paper, which highlights the results of a recently completed study of socioeconomic differences in infant mortality for metropolitan Ohio, helps to further our understanding of this fundamental relationship.

Data and Methods

The research we report is based on an analysis of infant mortality differentials in a metropolitan aggregate comprising eight Ohio cities (Akron, Cincinnati, Cleveland, Columbus, Dayton, Lima, Toledo, and Youngstown), and covers the years 1979–81. The general design of the research was an ecological one in which the primary analytical unit was the census tract of mother's usual residence. The independent variable is defined as the percentage of low-income families in each census tract at the 1980 decennial census. An annual income of $10,000, or roughly 50 percent of the median family income, was selected as the low-income cutoff point.

The dependent variable data consist of counts of the number of live births in each census tract during 1980 and the number of infant deaths in the 3 years centering on the census date (1979–81). The analysis first used the income variable to aggregate the census tracts of the eight cities into broad groups in such a way that an approximately equal number of tracts fell into each income status group. The resulting aggregates were then ranked and compared in terms of levels of infant mortality—total, neonatal, and postneonatal. These comparisons were, where feasible, carried out separately for the total, for males and females, by color, and for broad cause of death categories. In the more detailed cause of death analysis reported in this paper, the census tracts were grouped into three income aggregates (table 1). A preliminary examination of the data indicated that a larger number of groupings would have introduced a serious problem of rate instability because of small cell frequencies in the more detailed cross-tabulations. Even with only three areas, small frequencies became a problem when specific causes of death were considered, and many of these comparisons had to be limited to the total population.

General Findings

Conventional 3-year average infant mortality rates (total, neonatal, and postneonatal) for the three income aggregates identified in table 1 are presented in table 2. Inspection of these rates suggests two major conclusions. First, reflecting the obvious urban bias of the present sample, the overall Ohio rates are notably higher than comparable rates for the United States. The 1980 rates per 1,000 live births for the nation as a whole were 12.6 total mortality, 8.5 neonatal, and 4.1 postneonatal (*14*). This observation is not surprising and merely reflects the fact that poverty-level incomes and various socioeconomic correlates of

poverty are much more prevalent in central cities. In Ohio, for example, median family income for the State as a whole was $17,754 as compared with only $14,085 for the central city aggregates.

The second conclusion is that there is an obvious and extremely pronounced inverse association between infant mortality rates and economic status. The differential is quite marked for both neonatal and postneonatal components of infant mortality, although it is somewhat wider for the postneonatal period where exogenous causes (defined subsequently) still play an important though substantially reduced role as causes of death. Moreover, the data presented in table 3 clearly reveal that this pronounced economic mortality differential in infancy characterizes both sexes as well as the two major racial groups in the society. Although similar patterns are apparent, it should be noted that, in line with the basic sex-color mortality differentials, the parallel rates are notably higher for males than females, and especially for nonwhites as compared with whites. Despite such variations in magnitude, the major conclusion to be derived from these data is that the traditional inverse association between infant mortality and family income status, first documented in this country in 1925 (*15*), continues to be very pronounced, and that it characterizes both the neonatal and postneonatal components of infant mortality, for both sexes and for both major racial groups.

Table 3. Infant mortality rates by sex and color for income areas, metropolitan Ohio, 1980

Income areas, sex, and color	*Total*	*Neonatal*	*Postneonatal*
Males			
All areas	18.5	12.1	6.4
I High	12.4	8.7	3.7
II Medium	18.0	12.3	5.7
III Low	25.7	15.6	10.0
Females			
All areas	14.6	9.0	5.6
I High	10.1	6.5	3.6
II Medium	15.0	9.3	5.7
III Low	19.2	11.5	7.7
White			
All areas	12.7	8.0	4.7
I High	10.4	6.9	3.5
II Medium	13.9	8.6	5.3
III Low	16.6	9.8	6.8
Nonwhite			
All areas	22.5	14.5	8.0
I High	16.4	11.8	4.6
II Medium	20.6	14.3	6.4
III Low	25.2	15.3	9.9

Cause of Death

To understand more fully the nature of the association between income status and levels of infant mortality, it is necessary to undertake a cause-specific analysis to see if the general inverse nature of the relationship can be explained largely in terms of a few selected causes or groups of causes, or if it more or less characterizes all the major causes of death. Although it would naturally be desirable to consider all possible causes in such an analysis, the fact that a marked reduction in the number of cases enhances the likelihood of rate instability when specific causes are considered necessitated basing the analysis on only a few of the more prevalent specific conditions within two broad categories. These are *exogenous* causes of death (those whose origin is farthest removed from the actual birth process) and *endogenous* causes of death (those whose origin is most closely associated with the physiological processes of gestation and birth). The specific causes selected, along with their identification codes from the Ninth Revision of the International Statistical Classification of Diseases and Causes of Death, are as follows:

Exogenous causes
- Infectious causes (001-139, 320-323, 460-466, 480-487, 500-508, and 771)
  - Respiratory infection (460-466, 480-487 and 500-508)
  - Other infection (residual)
- Injury or poisoning (800-999)

Endogenous causes
- Congenital anomalies (740-759)
  - Congenital anomalies of the circulatory system (745-747)
- Conditions originating in the perinatal period (760-770, 772-779)
  - Fetus or newborn affected by maternal conditions or labor complications (760-763)
  - Short gestation and unspecified low birth weight (765)
  - Birth trauma or asphyxia (767-768)
  - Respiratory distress syndrome (769)
  - Other respiratory conditions of newborn (770)
  - Residual perinatal conditions (764, 766, 772-779)
- Sudden infant death (798)
- Residual endogenous conditions (390-459, 470-478, 490-496, and all causes not elsewhere classified)
  - Diseases of the circulatory system (390-459)
  - Chronic respiratory conditions (470-478, 490-496, 510-519)

The overall exogenous and endogenous death rates for the three income areas, by broad age category, are shown in table 4. Once again, two

Table 4. Infant mortality rates (per 100,000 live births) by cause of death group for income areas, metropolitan Ohio, 1980

Income areas	Exogenous causes			Endogenous causes		
	Total	Neonatal	Postneonatal	Total	Neonatal	Postneonatal
All areas	227	69	158	1,432	990	443
I High	129	57	72	998	703	295
II Medium	201	61	140	1,453	1,023	429
III Low	363	92	271	1,881	1,262	618

Table 5. Sex-color specific infant mortality rates (per 100,000 live births) by cause of death group for income areas, metropolitan Ohio, 1980

Income areas	All classes	Male	Female	White	Nonwhite
Exogenous causes					
All areas	227	249	205	169	314
I High	129	141	115	122	[1]166
II Medium	201	219	182	171	248
III Low	363	402	325	302	392
Endogenous causes					
All areas	1,432	1,648	1,262	1,100	1,940
I High	998	1,139	897	914	1,477
II Medium	1,453	1,627	1,314	1,220	1,814
III Low	1,881	2,207	1,589	1,357	2,129

[1]Based on fewer than 5 deaths.

conclusions are readily apparent from these data. First, the vast majority of infant deaths today are caused by the endogenous conditions that are most closely associated with the physiological processes of gestation and birth: in metropolitan Ohio for the 3 years 1979–81, 86 percent of the deaths under 1 year of age were attributed to one or another of the endogenous causes. Second, both the exogenous and endogenous cause-specific death rates are inversely associated with family income status. Not surprisingly perhaps, the strength of the relationship, as measured by the difference between the death rates of the highest and lowest income areas, is much greater for the environmentally related exogenous causes such as infections, accidents, and poisonings. The Area III exogenous death rate is nearly three times greater than that in Area I; in contrast, the Area III endogenous death rate is only twice as great as the corresponding Area I endogenous death rate.

Further, there is a tendency for the exogenous causes to account for an increasing proportion of total deaths as income status decreases: 11 percent of the infant deaths in Area I as compared with 16 percent in Area III were due to exogenous causes. It is thus clear that, despite the much lower absolute death rate, the increased risk of dying as economic status declines is relatively much greater for the environmentally related exogenous causes than it is for the endogenous causes. However, the fact that the inverse association between infant mortality and economic status is much more pronounced for those conditions that can generally be regarded as most amenable to societal control must not lead one to downplay the existence of a consistent and pronounced inverse relationship for those less resistant endogenous conditions that account for the vast majority of infant deaths.

Inspection of the exogenous-endogenous rates for the neonatal and postneonatal ages reveals that the pronounced inverse association with economic status characterizes both cause groups for both segments of infant mortality. The more interesting point here, however, is perhaps the challenge these data pose to the traditional distinction between neonatal-endogenous as opposed to postneonatal-exogenous mortality. In the past, demographers and other epidemiologic researchers have commonly used the neonatal and postneonatal death rates as proxies for endogenous and exogenous mortality (*16*). While the Ohio data show a clear preponderance of endogenous causes in the neonatal period (93 percent), they also reveal a preponderance of endogenous causes among postneonatal deaths (73 percent)! The increasing importance of the endogenous causes in the latter period likely

reflects the nature of the technological progress made in recent years in enhancing the survivability of high-risk births. That is, many infants who a generation ago would have died within the first few days or weeks after birth now have a much greater chance of surviving. For some, this change will mean a chance to survive infancy and grow to adulthood leading relatively normal lives. For others, it will mean that they are able to survive the neonatal period only to succumb later in infancy—thus increasing the frequency of deaths due to endogenous causes in the postneonatal period (*17*). In any case, these findings clearly indicate that there is no longer any basis for assuming an age-cause proxy relationship in infancy such as may have existed in the past.

Endogenous and exogenous death rates by sex and color are presented in table 5. Because of the earlier noted problems of rate instability due to insufficient numbers of cases, neonatal-postneonatal subdivisions have not been shown in this table. With respect to the overall rates, however, it is clear that the same general conclusions cited previously apply to both sexes as well as to the two racial groups: endogenous causes clearly predominate in all categories, and both cause-specific rates are inversely related to income status for all sex-color groups. Further, as was the case with total infant mortality, parallel rates are everywhere higher for males than females, and higher for nonwhites than whites.

Overall then, the data presented in tables 4 and 5 clearly show that the basic inverse relationship between infant mortality and socioeconomic status cannot be attributed solely, or even largely, to either group of causes. Although there are more deaths due to endogenous than exogenous causes, and more deaths in the neonatal period irrespective of cause, clearly the variations in the death rates for both broad cause groups are characterized by a similar inverse socioeconomic differential for all major subgroups in the society. In the following paragraphs, this association is examined for more specific components of the broad exogenous-endogenous split (table 6). Again the potential problems of rate instability have meant that these rates for more specific causes can only be shown for the total population.

Exogenous causes of death. Although the data permitted the selection of only two major cause groups—infections and injury or poisoning—the rates that could be reliably calculated show a dramatic increase as economic status declines, with the death rates in Area III being anywhere from 2.5 to 3 times greater than the corresponding rates in Area I. These differences are, with a few notable exceptions, greater than those characterizing the endogenous cause-specific death rates, and they clearly reveal the detrimental influence of a low economic status on the incidence of disease and death from those environmentally related causes that are generally thought to be more easily controlled through such things as improved education, sanitation, medical technology, and nutrition.

Table 6. Infant mortality rates (per 100,000 live births) for specific exogenous and endogenous causes for income areas, metropolitan Ohio, 1980

Specific causes of death	*All areas*	*I High*	*II Medium*	*III Low*
Exogenous causes				
Total exogenous	227	129	201	363
Infectious causes	181	107	147	301
Respiratory infection	95	52	76	164
Other infection	86	55	71	137
Injury or poisoning	46	[1] 22	54	62
Endogenous causes				
Total endogenous	1,432	998	1,453	1,881
Congenital anomalies	275	248	282	296
Circulatory system	108	77	106	143
Other	167	171	176	153
Perinatal conditions	780	503	806	1,052
Labor complications	103	79	123	105
Immaturity	135	62	159	188
Birth trauma	100	82	88	135
Respiratory distress	185	112	194	256
Other respiratory	135	92	135	180
Residual	122	76	107	188
Sudden infant death	138	59	142	218
Residual endogenous	239	188	223	315
Circulatory system	94	82	102	100
Chronic respiratory	58	37	52	89
Other (not elsewhere classified)	88	69	69	126

[1]Based on fewer than 5 deaths.
NOTE: See text for identification of specific causes and ICD codes.

Endogenous causes of death. Although the differences are generally not as wide nor as consistent as with the exogenous causes, the endogenous cause-specific rates also tend to exhibit a marked inverse association with income status. At the same time, there are a number of apparent deviations that merit comment. To begin with, it appears that the overall slight inverse association between income status and the congenital anomaly death rate is due primarily to a fairly strong association for congenital anomalies of the circulatory system where the Area III death rate is nearly twice that of Area I. For the residual group, "other," the pattern is fairly erratic but tends toward a direct

association with income status. Many of the conditions here reflect faulty fetal development, or they may even be genetic in origin (for example, 758, chromosomal anomalies), and are thus less likely to be influenced by economic status factors. However, the clear inverse association with respect to the circulatory system anomalies does point to the importance of economic status for this group of causes.

Considering the perinatal conditions, all rates except those based on deaths due to maternal or labor complications (760–763) exhibit a fairly strong inverse association with income status. For the exception, although an inverse tendency may be suggested by the fact that the Area I death rate is notably lower than that of Areas II and III, the more interesting fact is that the highest death rate is found in Area II. Moreover, although not shown here, this pattern characterizes both males and females, and both the white and nonwhite segments of the population. The reasons for this anomaly, as well as those noted subsequently for the residual group, are unclear.

With respect to suddent infant death syndrome (798), the inverse association is stronger than for any other specific cause group: the SIDS death rate increases monotonically in near linear fashion from 59 per 100,000 live births in Area I to 218 in Area III. This is a difference of approximately 270 percent and is the largest cause-specific differential observed in the Ohio data.

Finally, table 6 shows the association between infant mortality and income status for the residual cause groups broken down into (*a*) diseases of the circulatory system, (*b*) chronic respiratory conditions, and (*c*) a residual group composed of all other causes of death not elsewhere classified. The pattern that characterizes the diseases of the circulatory system resembles somewhat the one just described for the maternal-labor complications. That is, an inverse tendency is suggested by the lower death rate of Area I, but the highest rate is found in the middle rather than the lowest income tertile. There may be something about these two conditions that makes them less susceptible to differences in socioeconomic status, but otherwise the reason for the apparent curvilinear pattern is not clear.

With respect to the chronic respiratory conditions, there is a clear and fairly strong inverse association with income status, and there is also a fairly strong, although not consistent, inverse pattern characterizing the remaining residual cause group.

Overall then, despite some noteworthy deviations, the predominant patttern to emerge in this examination of selected endogenous causes of death is one that clearly illustrates the serious adverse effects of a low economic status on the life chances of a newborn infant. These endogenous causes historically were less prominent contributors to the socioeconomc differential (when a larger share of infant deaths occurred in the postneonatal period and were due mainly to various exogenous causes), and it was generally thought that they were less amenable to control through socio-medical intervention than the exogenous diseases. Today, however, the fact that neonatal mortality has emerged as the major contributor to the traditional socioeconomic differential, coupled with the existence of a marked inverse association between income status and endogenous mortality, represents a major challenge to this assumption. On the contrary, the Ohio data clearly point to the existence of some kind of control mechanism, differentially distributed among the economic classes in society, that is applicable to the endogenous causes of death.

Concluding Comments

In spite of significant progress in maternal and infant health care and associated substantial declines in the overall level of infant mortality in the United States in recent years, the data generated by the present study, as well as those of other related research, clearly point to the existence of a strong and persistent inverse association between economic status and the probability that a newborn infant will not survive the first year of life. Although there were occasional exceptions or varying degrees of deviation from the general pattern, or both, the overriding conclusion to be derived from the research we report is that the lower income groups in American society have long been and continue to be characterized by infant mortality rates that are substantially above those of high-income groups.

This conclusion implicitly assumes that causality runs solely from low income to high infant mortality, ruling out any causal relationship from poor health to low income. While such an assumption can be justified on the grounds that we are dealing here with infants rather than adults, it is possible that the general inverse relationship reflects two-way causality and that, where infant mortality rates are high, the health of all segments of the population is likely to be poor.

The persistence of such a strong inverse association between infant mortality and income status in the face of the marked overall declines of recent years clearly points to the existence of a social class differential in access to health care services and facilities. That is, the first to benefit from advances in medical technology and other health care improvements are those in the highest income classes; only gradually do the fruits of such progress filter down to the economically deprived groups in the society. Such a situation reflects what can only be characterized as an elitist approach to the delivery of health care in the United States. In a nation where we like to think that adequate health care is a basic right for all citizens, and not just an expensive privilege for those who can afford it, such a situation presents a major challenge to all maternal and child health professionals.

'. . . the first to benefit from advances in medical technology and other health care improvements are those in the highest income classes; and only gradually do the fruits of such progress filter down to the economically deprived groups in the society.'

Efforts to meet this challenge must, of course, be guided by the knowledge that a wide variety of factors associated with a low socio-economic status contribute to the observed differences in mortality, and each of these factors will require very different kinds of programs to bring them under control. In the past, major control efforts focused on those factors that exerted a direct influence on the survival chances of infants (for example, nutritional adequacy of their diet; the quality of housing, water, and home sanitary facilities; immunization status). These factors, which directly influence exogenous causes (such as parasitic diseases and respiratory infections) have already been brought fairly well under control by various public health programs, and what were once the major killers of infants and young children now account for a very small fraction of the total deaths under 1 year of age. Nevertheless, the fact that the exogenous disease death rates continue to vary inversely with economic status clearly indicates that the progress made in the prevention and treatment of these diseases has not benefited all groups equally, and there is an obvious need for continuing and even stepping up activities to extend the full benefits of past advances in medical knowledge and health care practices to the more economically deprived segments of the population.

By far the biggest challenge today, however, concerns the endogenous conditions which account for about four-fifths of all infant deaths. These causes, which have traditionally been regarded as less amenable to societal control, reflect such things as social class differences in reproductive behavior (age at childbearing, length of interval between pregnancies), differences in the amount and quality of prenatal care (timing of first prenatal examination, frequency of visits), and other maternal characteristics such as adequacy of diet during pregnancy, amount of weight gain, smoking habits, and the use of drugs or alcohol, or both. These are factors that generally have an indirect impact on infant mortality through their effect on pregnancy outcome—particularly on birth weight. The major policy goal, therefore, should clearly be one of preventing low birth weights, and recent evidence suggests that efforts to prevent low birth weight need to get away from simply providing more and better prenatal care services and concentrate on enhancing the overall quality of life of low-income mothers (*7*). While this may be viewed more as general social and economic policy rather than a specific maternal and child health policy, the fact is that the efforts in recent years to increase access to hospital-based prenatal services have not had much effect on reducing the proportion of low birth weight infants (*18*); nor are they likely to have such an effect as long as profound socioeconomic inequities continue to persist in American society.

In making this point, it can also be suggested that the decline in real per capita income from 1978 to 1983 and the corresponding increase in the overall poverty rate during this same period, which indicate an exacerbation of such socioeconomic inequities, could have the effect of impeding progress in preventing low birth weights and associated infant mortality; it could even cancel out some of the gains made during the 1960s and 1970s and lead to an increase in overall levels of infant mortality *and* to widening the socioeconomic differential. Such a possibility clearly emphasizes the importance of continuing to monitor

the trend of infant mortality in general and of the socioeconomic differential in particular.

With respect to a possible widening of the economic mortality differential, it should be noted that a major factor behind the declines in neonatal mortality that have occurred among low-income segments of the population has been the legalization of abortion (*19*). Should efforts to reverse the 1973 Supreme Court decision governing legal abortion be successful, it could have a significant impact on increasing neonatal mortality among these groups, leading to an even wider socioeconomic differential.

One other implication of recent trends merits consideration, and that relates to the success of those hospital-based efforts that led to the pronounced declines in neonatal mortality since the 1960s. One consequence of this success has naturally been the increase of high-risk infants. On the one hand, it has been suggested previously that, for some infants, this has meant only a postponement of death which then occurs later in the postneonatal period (*17*). On the other hand, and especially if the desired further reductions in infant mortality are realized, the society will be faced with the increasingly serious problem of providing the special medical, educational, and other support services that will be needed by those high-risk infants who do survive (*18*). Enhancing infant survival also requires efforts to ensure the quality of life for the surviving infants, and future maternal and child health policies and programs need to focus on the latter problem as well as on the former.

Much of the credit for past declines in infant mortality can be attributed to the sometimes dramatic advances made in health care knowledge and technology, but part of the credit must also be given to those federally funded programs that have sought to enhance the quantity, quality, and accessibility of maternal and child health educational and service programs. It is obvious that existing programs need to be maintained in order to hold on to those gains that have been made. At the same time there is an equally obvious need for stepped-up efforts to see that the full benefit of these as well as any new programs reach those economically deprived members of the society that are most in need of them. As suggested earlier, in an era when good health and access to good health care is seen as a basic human right for all citizens, rather than an expensive privilege for those who can afford it, finding ways to deliver the best care to all persons should be a major national priority.

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