Infant Mortality and Socioeconomic Status:

New Bottle, Same Old Wine

By

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Abstract

This paper presents the results of an ecological analysis of the relationship between infant mortality and economic status in metropolitan Ohio for the period 1960-2000. The data examined are centered on the five censuses undertaken during this 40 year period. The basic unit of analysis is the census tract of mother's usual residence, with economic status being determined by the percentage of low income families living in each tract. For each of the five periods covered, census tracts were aggregated into broad income areas and three-year average infant mortality rates were computed for each area, by age, sex, race and exogenous-endogenous causes of death. The most important conclusion to be drawn from the data is that in spite of some very remarkable declines in infant mortality at all class levels since 1960, there continues to be a very clear and pronounced inverse association between income status and infant mortality. Indeed, the evidence indicates that the relationship has become stronger over the years. These observations are applicable for both sexes, for whites and nonwhites, for neonatal and postneonatal deaths, and for both major cause of death groups. It is concluded that while public health programs are important, any progress in narrowing this long standing differential is unlikely unless ways can be found to enhance the economic well being of the lower socioeconomic groups.

Key words: Differential mortality, Infant mortality, Socioeconomic status

Introduction

The 20th century was characterized by, among other things, a marked improvement in the overall health status of the American population and a corresponding pronounced decline in mortality rates. These developments have been most dramatic with respect to infancy where the death rate has fallen from over 100 deaths under one year of age per 1,000 live births in 1900 (US Bureau of the Census, 1975) to less than 7 per 1,000 at the beginning of the present century (Minino, A. M., et al., 2002). Despite this overall remarkable decline, it has long been known that there are substantial and significant differences in infant mortality rates among the various segments of the population. In particular, the findings of numerous studies over the years have consistently shown that the lower socioeconomic status groups in our society have long been characterized by an extremely pronounced disadvantage when it comes to the chances that a newborn infant will survive the first year of life (Stockwell & Goza, 1994: 10-27).

Although research over the years has shown that the specific nature and magnitude of this relationship has varied over time (Stockwell et al., 1988; Antonovsky & Bernstein 1977; Kitagawa & Hauser 1973;) and from place to place (Statistics Canada 2002), a number of recent studies have documented the continued existence of an inverse association between infant mortality and various indicators of socioeconomic status, not only in the United States (Sohler et al. 2003; Mansfield et al. 1999; Gortmaker & Wise 1997; Pappas et al. 1993; Guest et al. 1988) but also in a number of other countries (Szwarcwald et al. 2002; Villanueva & Garcia 2000; Bennett 1999; Stainstreet et al. 1999; Lynch et al. 1994; Quine & Quine 1993). At the same time, however, still other studies have challenged both the universality and the strength of the relationship (Lynch et al., 2004; Finch 2003; Mellor & Milyo, 2002). These observations serve to emphasize the need for continuous monitoring of the relationship between infant mortality and income inequality so that relevant health and social agencies, both public and private, can adjust their policies and plan their programs accordingly. Previous research by the senior author and his associates has examined the nature of the relationship between socioeconomic status and infant mortality in the major metropolitan centers of Ohio for years centering on

1960, 1970, 1980, and 1990 (Stockwell et al., 1994). The purpose of the present brief article is to update and extend this earlier research by incorporating data for the most recent 2000 censal period.

Data and methods

The basic procedures followed in this research, which have been described more fully elsewhere (Stockwell & Wicks, 1981), utilized an ecological framework[1] in which the primary analytical unit was the census tract of mother's usual residence. The *independent variable* has been defined as the percentage of low income families in each census tract at the time of the decennial census. The low income cut-off points, defined as roughly 50% of the median family income in metropolitan Ohio for the year preceding the census enumeration, were $3,000 in 1960, $5,000 in 1970, $10,000 in 1980, $15,000 in 1990 and $25,000 in 2000. The *dependent variable* data consist of counts of the number of live births in each census tract during the census years, and counts of the number of infant deaths occurring during the three years centering on each census date, thus providing the data needed to calculate conventional three-year average infant mortality rates.

Despite the fact that the data were compiled from individual census tracts, it was not feasible to carry out the analyses on the basis of such units. This was because of frequent problems of rate instability at the individual tract level due primarily to the absence of any infant deaths, even over a three year period, yielding an infant mortality rate of zero. This problem became especially serious when we sought to examine more specific patterns of mortality based on age, race and/or cause of death. Accordingly, in order to increase the reliability of the dependent variable it was necessary to base the analyses on broader combinations of tracts. Specifically, we used the family income

[1] Ecological analysis suggests that neighborhood level health outcomes, including infant mortality, are influenced by a variety of conditions. As discussed above, these include census tract income level. Hypotheses are primarily defined with respect to ecological relationships at a single time, while others address shifts in relationship over time.

measure to aggregate the census tracts of the study cities into five broad income areas in such a way that, at each of the periods examined, approximately 20% of the tracts fell into each area. The analysis presented in this paper is thus based on three-year average infant mortality rates for five income areas in the metropolitan centers of Ohio at five points in time covering a period of forty years.

Results

The infant mortality rates in the income areas of metropolitan Ohio for the five dates covered by our data are presented in Table 1. With the exception of a slight tendency for the rates of the three intermediate areas to converge around the rate for all areas combined in 1970, these data reveal the existence and persistence of a fairly strong inverse association between family income and levels of infant mortality over the past forty years. Moreover, perhaps reflecting the well-documented trend toward greater income inequality in the United States (DeNavas-Walt et al. 2003), our data clearly suggest that this traditional socioeconomic differential has become even more pronounced over time. In 1960 the infant mortality rate for the lowest income area was nearly twice that of Area I (i.e., the ratio of the Area V infant mortality rate to that of Area I was 1.97); it was two and a half times as high in 1970 and by 1980 the infant mortality rate in the lowest income area was roughly two and three quarters times that of the highest income area. There was a slight drop back to a ratio of about 2.5 in 1990, but by 1999-01 the Area V infant mortality rate was nearly three times as high as that of Area I. Clearly, despite the spread of improved programs of maternal and child health and associated substantial declines in overall infant mortality during the past decades, we continue to be a society wherein the chances that a newborn infant will survive its first year of life are strongly influenced by the income of the family in which it happens to be born. Another possible explanation is that health status rises with each level of socioeconomic status. As such, those with the highest incomes would have access to the best medical care, food, housing, and healthiest lifestyles.

(Table 1 about here)

Age at death. The general trends just described seem to be primarily due to the changes that have occurred with respect to the neonatal mortality rate (See Figure 1). Since neonatal mortality accounts for the bulk of infant deaths, this is not really surprising: Since 1960 the neonatal death rate has declined consistently while at the same time exhibiting a general trend toward a wider gap between the highest and lowest income areas. The postneonatal death rate also exhibits a tendency toward a widening of the socioeconomic differential(See Figure 1a), but the most noteworthy observation to make here pertains to the seeming increase in postneonatal mortality between 1969-71 and 1979-81, an increase that is observed across all income levels. This reversal in the downward trend is very likely more apparent than real, however, and is probably due to the use of a larger data base beginning in 1979-81 (See note to Table 1), as the trends since that time have been consistently downward for all income levels. The major conclusion to be drawn from these data, we would suggest, is that the neonatal and postneonatal periods of infancy are both characterized by the prevalence of a fairly pronounced inverse association between the risk of dying and family income levels.

(Figures 1 and 1a about here)

Sex and Race. Males and females exhibit the same general trends with respect to both the existence of a marked inverse relationship between infant mortality and family income levels at every period examined, and the perceived widening of the income mortality differential over time (See Table 2). The socioeconomic differential has consistently been more pronounced for males, suggesting that male infants are somewhat more sensitive than females to variations in family economic status. However, we were unable to determine precisely why this variation occurred. Otherwise there are no really noteworthy sex differences with respect to the basic association.

(Table 2 about here)

Although there are no remarkable differences with respect to sex, the same cannot be said for race (See Table 3). For the white population, the pattern of the relationship between infant mortality rates and family income levels resembles the general pattern described above for the total population: There is a fairly consistent inverse association that has tended to become wider over the years. In sharp contrast, the existence of an inverse association between infant mortality and the overall income status of one's residential area appears to be a recent phenomenon for nonwhites. In 1960 there was an erratic pattern to the relationship, and in 1970, when a general converging trend was in evidence, there was very little difference in nonwhite infant mortality rates from one income area to another. In 1980, although it was not a consistent gradient, a general inverse pattern emerged for the first time for nonwhites. At first it might be suggested that the emergence of an inverse association for nonwhites in 1980 might be due to the larger data base (See note to Table 1); however, this was not enough for the association to hold up in 1990. At that date, as in 1970, there was relatively little variation among income areas in the level of infant mortality. The findings as of 1990, that nonwhites did not appear to experience any health benefits from living in higher income neighborhoods, had been observed by a number of other studies (Hummer 1993; Schoendorf et al. 1992; Kleinman 1985; Carlson 1984; Brooks 1975), and it was taken as an indication that race had an independent effect on levels of infant mortality (Stockwell & Goza, 1996).

(Table 3 about here)

At the most recent date, however, the nonwhite population exhibits a consistent and fairly pronounced inverse association between infant mortality rates and level of socioeconomic status. This observation suggests that as the overall economic status of the society as a whole has improved, and as infant mortality has declined over the years, the independent influence of race on infant mortality levels has lessened. Nonwhites continue to have infant mortality rates notably higher than those of whites at all income levels, but it is readily apparent that economic status exerts a strong influence on levels of infant mortality for both the white and nonwhite segments of the population.

Cause of death. It is common practice for studies of mortality to distinguish between two broad cause of death categories – those that reflect genetic make-up or internal physiological factors (*endogenous causes*), and those whose origin is presumed to lie in external or environmental factors (*exogenous causes*). The rationale for this distinction lies in the fact that the former causes are, with their biological basis, typically less responsive to scientific progress, whereas deaths attributed to the latter cause group, which result mainly from infection and accidents, are more easily preventable and treatable. With respect to infant mortality, this cause distinction has traditionally been important because it tended to parallel the division of deaths under one year of age into neonatal and postneonatal deaths. In fact, the neonatal-postneonatal split was frequently used as a proxy for the endogenous-exogenous cause distinction (Antonovsky & Bernstein 1977; Markides & Barnes 1977); however, a number of more recent studies have suggested that the more rapid declines in neonatal mortality since 1970 have considerably weakened the traditional age-cause proxy relationship (Kirby 1993; Stockwell et al. 1987; Poston & Rogers 1985). The weakening of this traditional relationship notwithstanding, it is still relevant to examine how the death rates for both groups of causes are influenced by levels of socioeconomic status.

(Table 4 about here)

The specific causes of death included in these two broad categories, along with their international list codes, are presented in Table 4, and the associated cause-specific death rates for the five dates covered by our research are presented in Table 5. Inspection of the data in the latter table again reveals that the previously described general patterns and trends with respect to the basic socioeconomic differential are characteristic of both broad cause groups. Further, our data show that the pattern for the endogenous causes parallels that described above for neonatal mortality while the exogenous pattern resembles that of postneonatal mortality. Thus, despite some suggestion that the traditional age-cause proxy relationship has weakened, our data suggest that there continues to be a fairly close fit between age and cause of death in infancy.

(Table 5 about here)

Discussion

Because our data are confined to a narrow geographic base, we are limited in our ability to draw broad and sweeping generalizations pertaining to *the* relationship between infant mortality and socioeconomic status. However, similar studies in Canada (Brownell et al. 2001), the United Kingdom (Whitehead & Drever 1999), and less-developed countries (Sastry 2004) have produced results that coincide with our own and reinforce these findings. As such, we would offer the following overall conclusion: In spite of some remarkable declines in infant mortality during the period covered by our research, most notably in neonatal mortality, a strong inverse socioeconomic mortality differential has not only characterized our study population at each date considered, but has also tended to become even more pronounced over time. The declines that have occurred in infant mortality in general, at all class levels, clearly reflect the success of recent efforts to enhance the quality and availability of maternal and child health care. At the same time, the failure of these programs to be accompanied by any leveling of the socioeconomic gradient or any narrowing of the mortality gap between the higher and lower income groups just as clearly emphasizes the fact that straight forward public health programs have not been, nor will they ever be sufficient by themselves to bring about any lessening of the long standing inverse association between infant mortality and socioeconomic status.

Thus, while infant mortality can be viewed as an important public health problem in our society, it must be viewed as one that has strong socioeconomic determinants (Sohler et al. 2003). There exists some kind of dynamic but as yet not fully understood interrelationship between income inequality, health care and health status, and any public health initiatives aimed at eliminating or even modifying the socioeconomic differential must, if they are to succeed, incorporate related programs for enhancing the economic well being of the lower socioeconomic groups. In a society where income inequality has been increasing and where numerous social programs are being cut back this represents an especially difficult challenge, but it is a challenge that must be met if we are ever to achieve greater parity in infant mortality across income lines.

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Table 1. Infant mortality rates in the income areas of metropolitan Ohio (deaths per 1,000 live births): 1960-2000.*

Income Areas	Years				
	1959-61	1969-71	1979-81	1989-91	1999-01
All areas	25.6	19.3	16.6	13.2	10.0
I (High)	17.7	11.4	8.9	7.6	6.0
II	21.6	19.3	14.3	9.2	7.4
III	25.7	18.9	16.4	13.1	9.5
IV	31.7	21.4	19.7	14.9	14.1
V (Low)	34.9	28.7	24.3	18.8	17.0
Ratio: V/I	1.97	2.52	2.73	2.47	2.83

* For 1959-61 and 1969-71 the data refer to a three-city aggregate comprised of Columbus, Dayton and Toledo. For subsequent dates, however, the data refer to a larger aggregate comprised of eight (1979-81), seven (1989-91) and six cities (1999-01). The 1979-81 cities were: Akron, Cincinnati, Cleveland, Columbus, Dayton, Lima, Toledo and Youngstown. The 1989-91 cities were: Akron, Cincinnati, Cleveland, Columbus, Dayton, Toledo and Youngstown. Finally, the 1999-01 cities were: Akron, Cincinnati, Cleveland, Columbus, Dayton, and Youngstown. The use of larger aggregates for the three later dates was based on the availability of data for more cities as well as a desire to minimize potential problems of rate instability that could arise from smaller numbers of infant deaths, especially when total infant mortality was broken down into its various component parts. Further justification for the use of the multiple city aggregates was provided by looking at 1979-81 and 1989-91, the two dates for which data were available for both a three-city aggregate and a multiple-city aggregate, and comparing the resulting infant mortality rates. While the multiple-city aggregates yielded somewhat higher levels of infant mortality in all income groups, there were no noteworthy differences between them with respect to the overall pattern of the relationship (See Stockwell et al., 1986, and Stockwell & Goza, 1994).

Figure 1. Neonatal mortality rates in the income areas of metropolitan Ohio (deaths per 1,000 live births): 1960-2000.

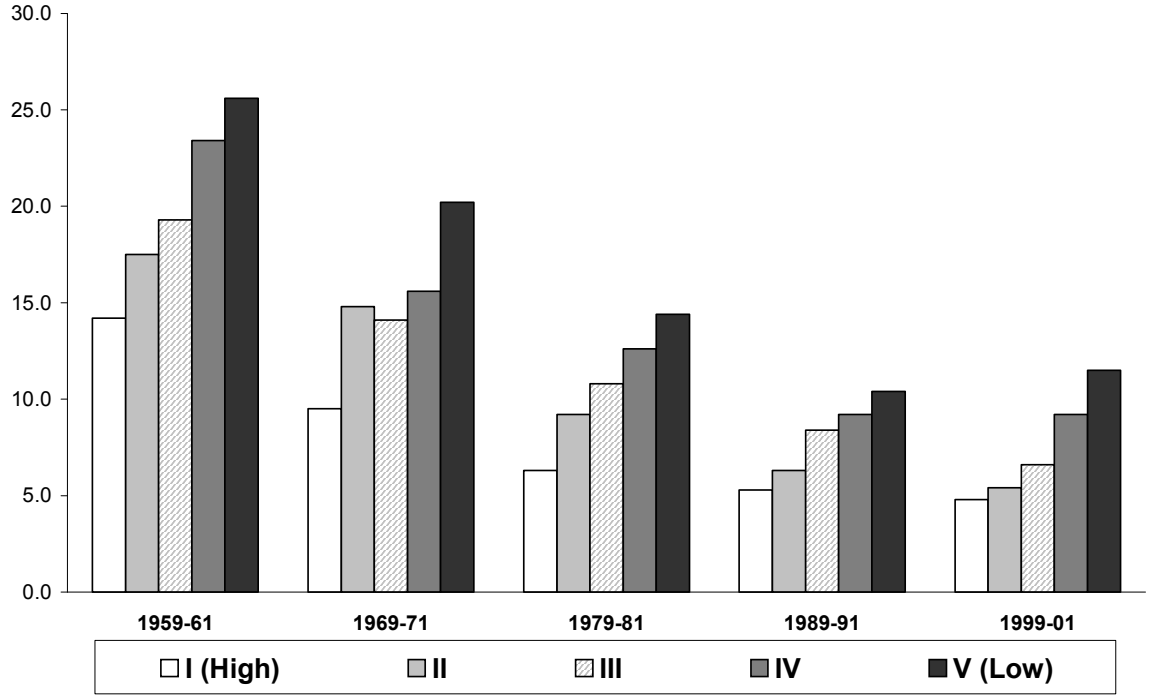

Figure 1a. Postneonatal mortality rates in the income areas of metropolitan Ohio (deaths per 1,000 live births): 1960-2000.

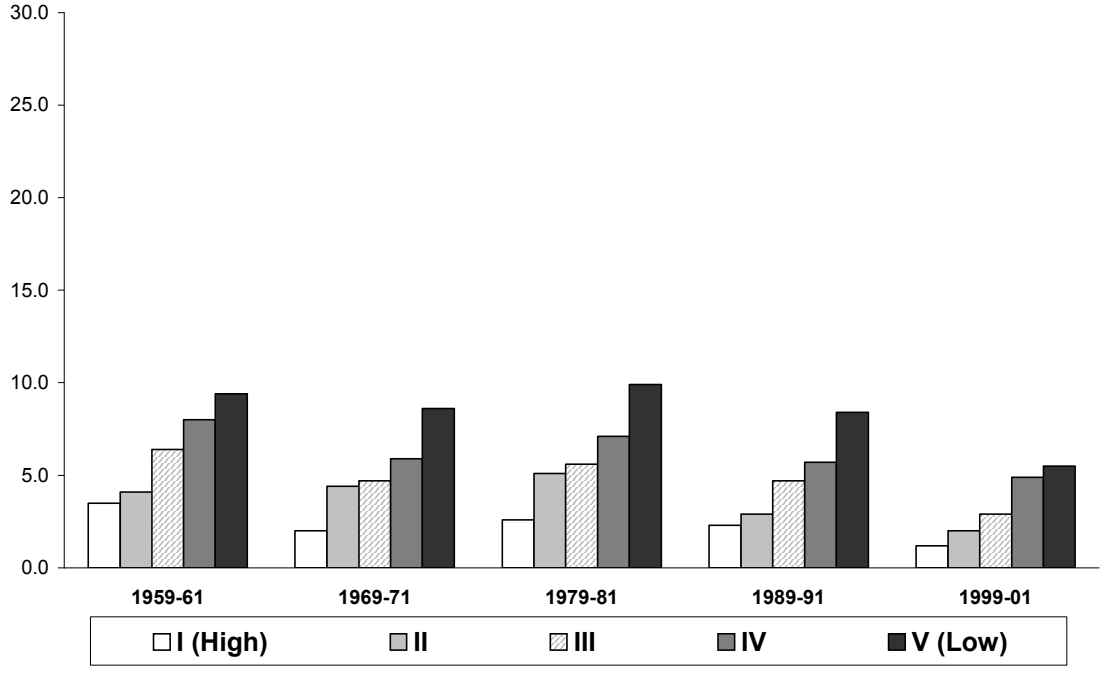

Table 2. Infant mortality rates, by sex, in the income areas of metropolitan Ohio (deaths per 1,000 live births): 1960-2000.

Income Areas	Years				
	1959-61	1969-71	1979-81	1989-91	1999-01
			Male		
All areas	28.5	21.8	18.5	14.8	11.1
I (High)	17.4	13.0	8.9	8.0	6.5
II	25.8	22.1	16.4	11.0	8.0
III	27.2	21.3	17.6	14.7	11.0
IV	37.1	23.7	21.7	17.0	16.1
V (Low)	40.6	33.3	28.6	20.8	19.1
Ratio: V/I	2.33	2.56	3.21	2.60	2.94
			Female		
All areas	22.7	16.4	14.6	11.5	8.8
I (High)	18.0	9.7	8.9	7.3	5.5
II	17.2	16.1	12.0	7.4	6.8
III	24.3	15.6	15.1	11.5	8.1
IV	26.7	19.0	17.6	12.7	12.2
V (Low)	29.9	23.8	19.9	16.7	14.8
Ratio: V/I	1.66	2.45	2.24	2.29	2.69

Table 3. Infant mortality rates, by race, in the income areas of metropolitan Ohio (deaths per 1,000 live births): 1960-2000.

Income Areas	Years				
	1959-61	1969-71	1979-81	1989-91	1999-01
			White		
All areas	22.8	16.5	12.7	9.5	7.1
I (High)	17.7	11.2	8.2	6.7	5.8
II	20.5	17.9	12.8	7.7	6.5
III	25.8	15.7	14.5	10.6	6.8
IV	27.1	18.8	15.6	10.7	10.1
V (Low)	32.4	27.1	17.6	16.2	14.4
Ratio: V/I	1.83	2.42	2.15	2.42	2.48
			Nonwhite		
All areas	35.6	27.1	22.5	18.1	15.6
I (High)	*	*	14.2	17.8	8.5
II	27.1	29.1	19.6	15.9	11.9
III	25.2	25.6	19.2	17.2	14.8
IV	40.0	25.6	23.0	17.7	16.8
V (Low)	36.8	29.8	26.7	19.7	17.9
Ratio: V/I	…	…	1.88	1.61	2.11

* Less than 10 deaths; rate not computed.

Table 4. Infant mortality endogenous/exogenous cause of death groupings.

Cause categories	*International list codes*			
	1960 (ICD-7)	1970 (ICD-8)	1980 & 1990 (ICD-9)	2000 (ICD-10)
Endogenous causes				
1. Congenital anomalies	750-759	740-759	740-759	Q00-Q99
2. Birth injuries	760, 761	764-772	760-763	P10-P15
3. Postnatal asphyxia (RDS)	762	776	769	P22
4. Immaturity (unqualified) and other diseases of early infancy	760-763 763-776 777-778	774	764-768 770 772-779	P00-P29 P50-P96
Exogenous causes				
5. Acute/infectious and parasitic	001-136 470-475 480-483 490-493 543 571-572	001-136 460-465 470-474 480-486	001-139 460-466 480-487 500-508	A00-B99 P35-P39
6. External causes	E800-962	E800-949	E88-999	V01-Y84
7. Other causes of death	Residual	Residual	Residual	Residual

Table 5. Infant mortality rates, by broad cause of death, in the income areas of metropolitan Ohio (deaths per 1,000 live births): 1960-2000.

Income Areas	Years				
	1959-61	1969-71	1979-81	1989-91	1999-01
	Endogenous causes				
All areas	21.0	14.5	8.8	6.9	6.3
I (High)	16.1	9.2	5.4	5.2	4.2
II	17.8	15.1	7.2	5.0	5.0
III	21.2	14.3	7.7	7.5	6.2
IV	25.0	15.9	10.7	7.5	8.8
V (Low)	27.1	20.1	11.7	8.2	9.5
Ratio: V/I	1.68	2.18	2.17	1.58	2.26
	Exogenous causes				
All areas	4.9	4.9	5.5	4.4	3.7
I (High)	2.2	2.4	3.4	1.6	1.8
II	3.7	4.3	2.9	2.7	2.4
III	4.9	4.7	6.4	2.7	3.4
IV	7.2	5.6	6.1	4.9	5.4
V (Low)	7.8	8.8	8.3	7.8	7.5
Ratio: V/I	3.55	3.67	2.44	4.88	4.17