Infant Mortality and Socioeconomic Status in a Metropolitan Community

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MORTALITY RATES for most age groups have declined remarkably during the past 50 years in the United States and elsewhere. Although this decline has been proportionately far greater for the younger than for the older age groups, infant mortality rates are still high (*1–3*). Fetal deaths after the 20th week of gestation combined with deaths during the first week after birth are equal in number to all deaths during the subsequent four decades of life (*4*).

Because the rate of decline of infant and perinatal mortality has slowed down in recent years, this problem has received renewed attention. Beginning about 1950, with some variations among the States, the rate of decrease in infant mortality dropped from 4.3 percent per year (1933–49) to about 2 percent per year (*5*). According to Hunt (*6*): "Since the mid-1950's, national progress in reducing infant mortality has been close to a standstill."

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Evidence from several sources indicates that this slackening does not mean that we have achieved the minimum levels of infant mortality. During the past decade, U.S. infant mortality was reduced to a lesser extent than that in 14 other "advanced countries." In 1959–61 nine of these countries had lower infant mortality rates than the United States, signifying a relative worsening in our position during the past decade (*6*). In fact, "Not one of the U.S. States had infant death rates in 1962 as low as the 15.3 per 1,000 of the Netherlands and Sweden, but ranged from the low of 19.7 in Utah to 40 in Mississippi. If all States had rates as low as in Utah, the lives of 23,000 who now die before their first birthday would be spared" (*7*).

Infant mortality has become especially acute in the larger cities (*6*). ". . . Only Houston and Los Angeles among the 10 largest cities had lower infant death rates in 1961 than in 1950. In all but four of these cities (New York, Los Angeles, Houston, and the District of Columbia) the death rate increased for white as well as for nonwhite infants during this period" (*7*).

Differences in infant mortality by socioeconomic status also indicate that the low levels attained by certain segments of the population need not remain unattainable for the less favored (*8–12*). Again, the differences are striking in the larger cities. Here, differences between one census tract and another and one neighborhood and the next reveal what remains to be accomplished (*6, 13–15*).

Obviously, many factors—biological, genetic, environmental, and sociocultural—determine the differences observed between nations, races,

urban or rural areas, and social classes. Not all of these are well understood or subject to easy alteration. However, both direct evidence (*16*, *17*) and indirect evidence (*18–20*) indicate that many of the causes of infant mortality can be prevented by medical knowledge and techniques we now possess but fail to apply.

In addition to the slowing down, and, in some cases, the arrest or even reversal, of the downward trend in infant mortality as a whole, certain components have proved appreciably more resistant to improvement than others. For example, during the past 50 years mortality during the ages of 1 to 11 months was reduced by 88 percent, whereas during the first 4 weeks of life it diminished by only 59 percent (*7*). The result has been a remarkable alteration in the pattern of infant mortality. In most advanced countries, losses during the first week of life now account for the largest proportion of infant deaths (*2*, *3*, *8*). This is in marked contrast to historic patterns in these countries and present patterns in underdeveloped countries, both of which show a relative preponderance of deaths later in the neonatal period or in infancy (*21*).

These differences in rates of decline and the proportion of deaths accounted for by different segments of infant mortality are generally attributed to the different causes of death in the several age groups. During the first week of life, deaths are usually caused by immaturity, birth injury, or congenital malformation—factors that have not responded as well to medical management as have the infections that cause most deaths during later periods of infancy.

In this country, "perinatal mortality," a term of fairly recent coinage, is used to include stillbirths and first-week deaths by some authors (*22*, *23*) and stillbirths plus neonatal deaths by others (*16*, *18*). There is little numerical difference between the two definitions because of the relatively small number of deaths that occur during the second to fourth week of life.

Our first interest in perinatal mortality and its relation to socioeconomic status was as a possible measure of unmet need for medical care (*24*). It soon became apparent, however, that the analysis of smaller segments of infant mortality by characteristics of areas of residence might constitute a valuable administrative tool for determining the magnitude and distribution of this mortality in an urban community. It would also provide a research tool for seeking clues to factors in the causation of the various components of infant mortality.

The manner in which stillbirths and subdivisions of infant mortality are related to socioeconomic status has received attention for some time, especially in Britain, where the father's occupation appears on vital records and provides a convenient, if approximate, measure of social classification (*10*, *11*, *25*). In recent years, several U.S. studies (*13*, *15*, *26*) have examined the distribution of infant mortality or some of its segments by using methods of social area analysis quite similar to those used in our study. This paper presents our findings and interprets them in the light of these studies and other relevant literature.

Method

A wedge-shaped segment of Metropolitan Boston, extending in a southwesterly direction from the center of the city, was chosen as the study area. This area includes 65 census tracts within Boston and all tracts in 6 contiguous townships, a total of 90 census tracts.

The study area was selected to represent a wide range of social and economic characteristics. A population of approximately 500,000 (about 20 percent of the inhabitants of Metropolitan Boston) seemed to provide an adequate base for statistical operations. The study area is fairly representative of the Boston Standard Metropolitan Area with respect to several demographic and socioeconomic characteristics, except that it has a larger proportion of Negro inhabitants.

For this study, perinatal deaths were defined to include stillbirths and neonatal deaths. Neonatal deaths are those which occur from 0 through 27 days of life. In Massachusetts, a stillborn child is defined as a "foetus born after a period of gestation of not less than twenty weeks, in which foetus there is no attempt at respiration, no action of heart and no movement of voluntary muscle." According to a personal communication from Dr. Gerald Rice, former director of the division of maternal and child

health, Massachusetts Department of Public Health, the official definition of stillbirth seems to be well understood and generally applied in Massachusetts. Nevertheless, there is no reliable estimate of error in distinguishing a stillbirth from a miscarriage or from a live birth.

Data on live births, stillbirths, and neonatal deaths during a 5-year period (1950–54) were obtained from the usual official sources. Data concerning live births in the study area outside the limits of Boston proper, comprising census tracts in the higher economic groups, were based on a one-third sample of birth certificates. Births which occurred to residents of the study area outside Metropolitan Boston were not sampled. The number of such births is believed to be extremely small. This is supported by the finding that, over a 5-year period, only 0.6 percent of neonatal deaths among residents of the study area were reported to have occurred outside of Metropolitan Boston.

All births and deaths were allocated to the census tract of the mother's residence, as determined by the address recorded on the corresponding certificate. Census tracts were assigned scores of socioeconomic status, using a modification of the method described by Shevky and Bell (*27*).

First, each census tract was assigned separate scores with respect to the following three characteristics, determined by the 1950 census: (*a*) median income of families and unrelated persons, (*b*) percentage of persons aged 25 years or older who completed high school, and (*c*) percentage of persons in the labor force who are professional, technical, or similar workers, managers, officials, or proprietors (including farm).

Each score was obtained by the following formula:

$$\text{Standardized score} = \frac{Cv - Lv}{Hv - Lv} \times 100$$

Cv is the median income, or percentage of high school graduates among persons aged 25 years and over, or percentage of persons aged 14 years and over in professional and managerial occupations for any one census tract. Hv and Lv are the highest and lowest values among all 90 census tracts of income, education, or occupation.

Second, the three standard scores for each tract were averaged to obtain a combined score of socioeconomic status. Income, education, occupation, and combined scores were used to rank the 90 census tracts in ascending order. Each array was then divided into five socioeconomic groups, and each group included 20 percent of the entire range (0–100) of the corresponding score. Group 1 was the lowest and group 5 the highest in socioeconomic rank. Because of the small population in group 5, the two highest socioeconomic groups were subsequently combined for purposes of analysis.

For each socioeconomic group the ratio or rate per 1,000 live births was computed for each of the following mutually exclusive segments: stillbirths, hebdomadal deaths (0 through 6 days), posthebdomadal deaths (7 through 27 days), and postneonatal deaths (28 days through 11 months). Combinations of these constitute neonatal deaths (0 through 27 days) and infant deaths (0 through 11 months). As part of the analysis it was also possible to examine mortality rates during three segments of the first week: 0 days, 1 through 2 days, and 3 through 6 days. The perinatal mortality rate was computed as follows: neonatal deaths plus stillbirths divided by live births plus stillbirths multiplied by 1,000.

The major focus of the study was the examination of the relationships of these segments of mortality to socioeconomic status or to each other, or both. The existence of significant relationships between mortality experience and socioeconomic category was tested by chi square.

Findings

The findings of the study are presented in two sections. The first describes the magnitude and spatial distribution of perinatal mortality using individual census tracts, or groups of such tracts, as the geographic unit of observation; the second concerns more specifically the relationships of discrete segments of mortality to socioeconomic status as determined by census tract characteristics.

Perinatal mortality in the 90 census tracts ranged from 13.9 to 75.4 per 1,000 births—more than a fivefold difference between the lowest and highest. As shown in figure 1, the areas which experienced different ranges of mortality

are clearly localized, with remarkable homogeneity among the census tracts within each area. Equally striking are the sharp limits that separate, in some instances, areas in the highest and lowest ranges of perinatal mortality. Invisible boundaries clearly separate the areas where the newborn tend to perish from those where they tend to survive. The nature of these boundaries can be surmised by comparing figure 1, showing the geographic distribution of mortality rates, with figure 2, showing the spatial distribution of socioeconomic status. The correspondence, though not complete, is quite striking.

Another aspect of infant mortality is the relative contribution of component segments of mortality to the total rate. As shown in figure 3, in census tracts with low infant mortality rates first-week deaths were predominant, as expected where high standards of health prevail. But in census tracts with an infant mortality of more than 50 per 1,000 live births, postneonatal deaths were predominant, a pattern similar to that for the United States as a whole in 1915, and comparable with the current pattern in partially developed countries (*21*). With respect to infant mortality, some areas of a modern American metropolis appear to be four decades behind the times.

The second set of findings concerning the relationships of perinatal mortality and its component segments to socioeconomic status are shown in table 1 and figure 4. Postneonatal deaths are included for comparison. An orderly decline occurred in perinatal mortality with rises in socioeconomic rank, as indicated by the combined score. This relationship is highly significant ($P<0.001$). But the three components of perinatal mortality seem to differ in the manner in which they, individually, relate to socioeconomic status. Although the stillbirth ratio runs a downward course roughly parallel to that exhibited by perinatal mortality, no significant relationship is apparent between first-week deaths and socioeconomic status (P between 0.5 and 0.3). Posthebdomadal mortality, a numerically minor component of perinatal mortality, is significantly related to socioeconomic rank but presents a somewhat different configuration. Socioeconomic improvements are at first associated with a steep reduction in posthebdomadal mortality, which then becomes relatively insensitive to further socioeconomic improvements. In this respect posthebdomadal

Figure 1. Perinatal mortality rates per 1,000 live births and stillbirths, by census tracts, Metropolitan Boston study area, 1950–54

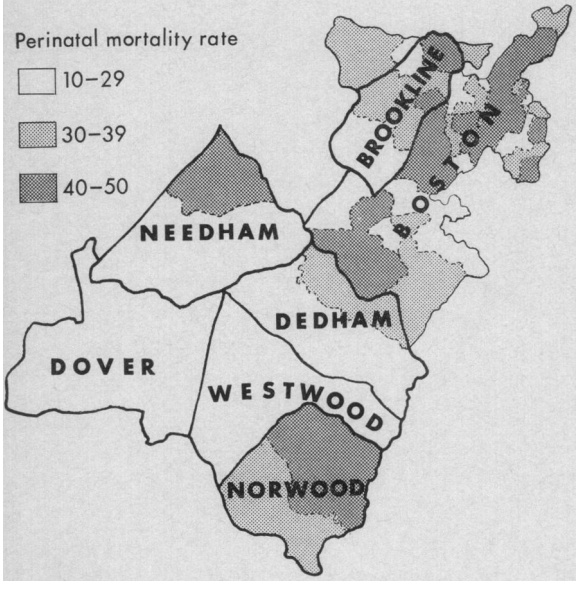


Figure 2. Groupings of census tracts ranked by a combined score of socioeconomic status, Metropolitan Boston study area, 1950–54

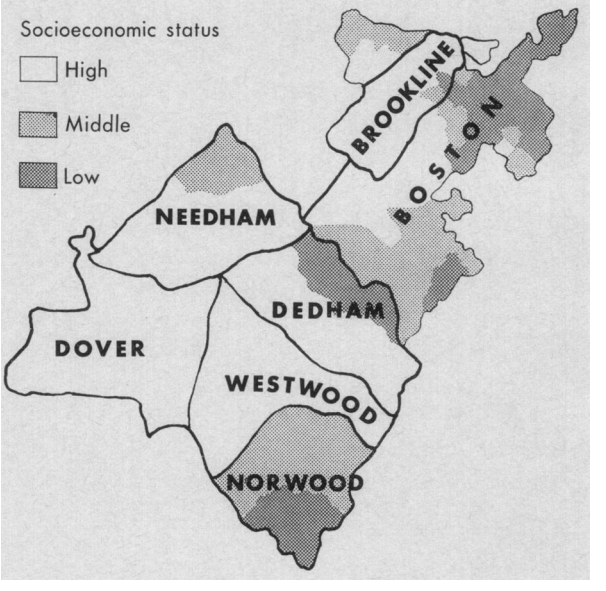
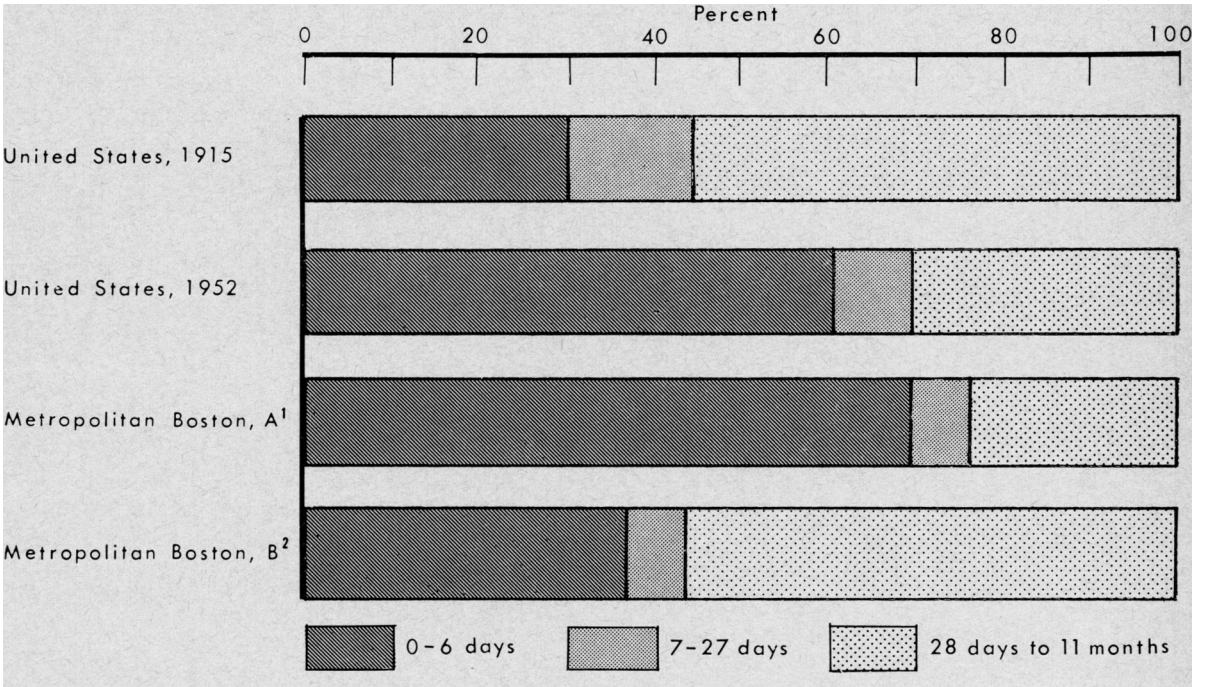


Figure 3. Percentage of total infant mortality by specified segments of infant mortality, United States, 1915 and 1952, and Metropolitan Boston study area, 1950–54



[1] Census tracts with infant mortality under 20 per 1,000 live births.
[2] Census tracts with infant mortality more than 50 per 1,000 live births.

mortality closely resembles postneonatal mortality. These findings, although they seem straightforward, raise intriguing questions of interpretation.

Interpretation of Relationships

The similar relationships of posthebdomadal and postneonatal mortality to socioeconomic status, while not established by the results of a single investigation based on fairly small numbers, are not unexpected. During the past several decades these two kinds of mortality have followed an almost parallel time trend which has differed appreciably in slope from that of the hebdomadal rate (*2*, *3*). The causes of death during the posthebdomadal period are similar to those during the postneonatal period in the relative importance of infection. In 1950, for example, pneumonia, influenza, diarrhea, and dysentery accounted for 2 percent of all deaths under 7 days, but for 21 percent of deaths during 7 through 27 days and 27 percent of those between 1 through 11 months (*3*).

It may be surmised that, under conditions prevailing in an urban center, the majority of infant deaths occurring after the first week of life are fairly susceptible to prevention through moderate improvement in socioeconomic level and the attendant amelioration in the standards of housing, nutrition, and medical care. A residuum of deaths remains relatively less susceptible to prevention in this way and accounts for the absence of further reduction with continued improvement in socioeconomic status. Willie and Rothney, using median income of census tract of residence as the measure of socioeconomic status, have noted a "critical income level" below which neonatal mortality was sensitive to income and above which no further reduction in mortality occurred with increasing income (*14*).

More difficult to account for are (*a*) the apparent lack of relationship between hebdomadal mortality and socioeconomic status and (*b*) the difference in this respect between hebdomadal mortality and stillbirth ratio. The following possible explanations have been considered.

There is reason to believe that death rates during the first week of life are less sensitive to

differences in socioeconomic level than death rates during other stages of infancy. This may be partly because in U.S. urban centers almost all births occur in a hospital, and perhaps close to 95 percent of first-week deaths take place before the infant is discharged (*28*). It follows that the newborn infant is subjected to much more uniform circumstances of environment and medical care than prevail at any other period of life. Deaths during the first week are also less easy to prevent. This is supported by the British data, which show little or no decline with improved social class in such common causes of hebdomadal deaths as congenital malformation and injury at birth. By contrast, deaths from bronchitis, pneumonia, gastroenteritis, and other infections common in the postneonatal period, show striking reductions with improved social rank.

It might, therefore, be reasonable to expect a less impressive correlation between hebdomadal death and socioeconomic status. A total absence of correlation, such as we noted, might have resulted from crudities in our method that obscure real relationships of smaller magnitude. In particular, the assumption that the average characteristics of census tracts adequately represent all its inhabitants can be only approximately true, because it depends on the degree of homogeneity within the census tract (*29*). Moreover, the derivatives of income, education, and occupation used in this study may not represent adequately all the relevant socioeconomic variables.

The methodological aspects of social area analysis, when applied to the epidemiology of mortality in general and infant mortality in particular, have been discussed by Stockwell (*13*, *30*) and Willie (*14*, *26*). Both have shown that the precise manner in which the socioeconomic index is constructed influences the magnitude of the association with mortality data and, in some instances, whether any association is found. They have also shown that median income of census tract of residence is perhaps the most discriminating variable in pointing out such associations.

Stockwell's findings in Providence, R.I., are especially pertinent to ours. Using an index almost identical to ours, he found no relation-

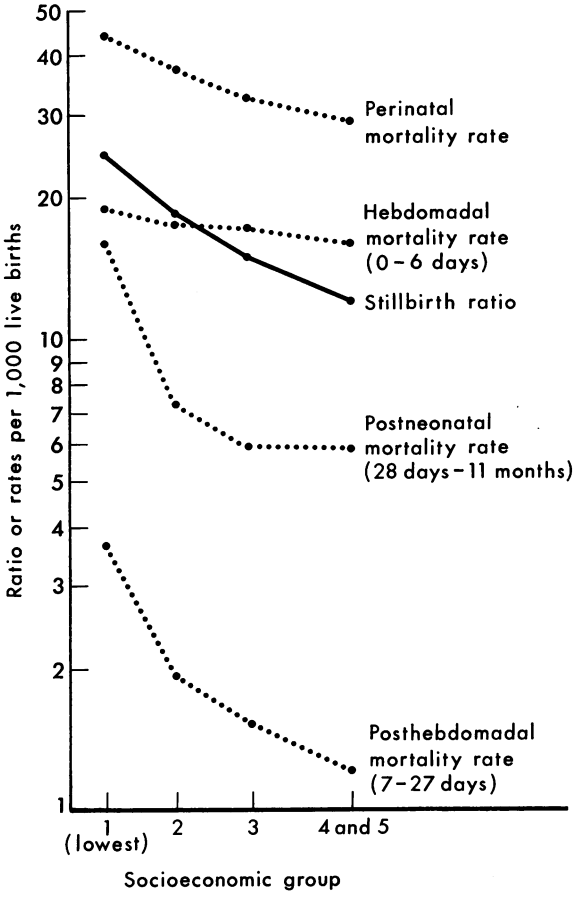
Table 1. Stillbirths and designated segments of infant mortality in four groups of census tracts ranked by a combined score of socioeconomic status, Metropolitan Boston study area, 1950–54

Socioeconomic group	Live births	Stillbirths	Hebdomadal deaths	Posthebdomadal deaths	Perinatal deaths [1]	Postneonatal deaths
	Number					
All groups	49, 939	834	851	92	1, 777	315
1 (lowest)	7, 092	176	132	26	334	114
2	15, 025	279	262	28	569	96
3	15, 028	228	254	23	505	71
4 and 5 (highest)	12, 794	151	203	15	369	34
		Ratio	Rate [2]			
All groups	----------	16. 7	17. 0	1. 8	35. 0	8. 3
1 (lowest)	----------	25. 0	18. 6	3. 7	46. 0	16. 0
2	----------	18. 6	17. 4	1. 9	37. 2	7. 3
3	----------	15. 2	16. 9	1. 5	33. 1	5. 9
4 and 5 (highest)	----------	11. 8	15. 9	1. 2	28. 5	5. 8

[1] Perinatal death rate $= \frac{\text{stillbirths} + \text{hebdomadal deaths} + \text{posthebdomadal deaths}}{\text{stillbirths} + \text{live births}} \times 1{,}000$

[2] Per 1,000 live births. The base for postneonatal rate is somewhat smaller than the live birth figures quoted because infant mortality figures are not available for some census tracts.

Figure 4. Stillbirth ratio and designated mortality rates in four groups of census tracts ranked by a combined score of socioeconomic status, Metropolitan Boston study area, 1950–54



ship between socioeconomic status and neonatal mortality, although socioeconomic status and postneonatal mortality were clearly related. This finding was attributed to differences in causes of death in the two age groups. Among the causes considered less amenable to improvement, birth injuries and immaturity occurred with equal frequency in all socioeconomic classes, whereas congenital malformations as a cause of death became more frequent with rising socioeconomic level. In our study, the relationships between perinatal mortality and socioeconomic status were quite similar, irrespective of whether income, education, or occupation were used separately or in combination as indices of socioeconomic status (table 2). In another of our studies in this series, the combined index of socioeconomic status proved successful in pointing out differences in prenatal care when it was compared with socioeconomic data obtained directly from the mothers concerned (*31*). Further studies are needed to compare the ability of personal characteristics versus social area to discriminate among various levels of mortality.

For the time being, we can accept that first-week deaths are, for the reasons discussed, less sensitive to socioeconomic differentials than other segments of infant mortality, and that this weaker association is likely to be obscured by cruder methods of determining socioeconomic rank. The next question is why stillbirths are so sensitive to socioeconomic differentials while first-week deaths apparently are not, when the same method of socioeconomic ranking is used.

One possibility is that this phenomenon results from errors in definition and reporting. Such random errors would be expected to affect all social ranks equally and would not, therefore, explain our findings. Our observations can be accounted for only by systematic bias leading to a misclassification of stillbirths as infant deaths in the higher social classes or faulty classification of infant deaths as stillbirths at the lower end of the social scale, or both. The assumption would be that the hebdomadal death rate and the stillbirth ratio actually decline roughly in parallel fashion with improvement of socioeconomic status. Further, some form of bias in definition causes apparent exaggeration in the decline of still-

Table 2. Perinatal mortality rates in five groups of census tracts ranked by specified indicators of socioeconomic status, Metropolitan Boston study area, 1950–54

Socioeconomic group	Indicator of socioeconomic status		
	Income	Education	Occupation
All groups	35.0	35.0	35.0
1 (lowest)	47.7	36.7	41.0
2	31.2	38.4	34.0
3	33.8	35.1	31.3
4	28.9	30.9	27.9
5 (highest)	23.5	27.0	28.5

births and a masking of that of hebdomadal deaths.

We have found little in the literature to support such a hypothesis. Schlesinger and associates (*15*) studied the incidence of fetal and early neonatal deaths (first 24 hours) in Onondaga County, N.Y., using hospital records as sources of information for classifying deaths. Quite contrary to our findings, they reported that fetal deaths were not related to socioeconomic status of census tract of residence, whereas deaths during the first 24 hours after birth were related to a high degree. The precise relevance of this finding to ours is somewhat obscured by their inclusion of all fetal deaths in their computation whereas we included only fetal deaths of 20 or more weeks' gestation. Since the latter constituted only 23 percent of the total fetal deaths in the Schlesinger study, any peculiar characteristics they might possess are likely to be obscured by the larger total. Just as for infant mortality, segments of fetal death may need to be separately related to socioeconomic status. Furthermore, Schlesinger and associates, far from showing significant errors in reporting, demonstrated remarkable accuracy, assuming, of course, that the data on the hospital records are themselves valid. Only 2 of 189 reported early neonatal deaths (within 24 hours of birth) were reported as stillbirths, and none of 202 reported late fetal deaths (28 weeks or over) were reported as neonatal deaths. Moreover, the reporting of these two categories was remarkably complete (98 percent and 94 percent respectively).

Somewhat kinder to the misclassification hypothesis are the findings of Pakter and associates (*23*) who noted, in a study of perinatal mortality in New York hospitals, that the highest fetal death ratio occurred in a proprietary hospital that reported an infant death rate of zero. The municipal hospital with the lowest infant death rate also had the highest fetal death ratio. The suggestion is that the distinction between live birth and stillbirth is often sufficiently tenuous to permit errors or even systematic bias to creep in.

Hypothetically, we have considered various possible sources of bias in classification. Infants with little evidence of life after delivery and who die soon after might be labeled stillborn out of careless habit. In some instances such cases might be reported as prepartum fetal deaths to avoid embarrassment for the medical attendant. Contrariwise, doubtful evidence might be interpreted as signs of life to meet certain religious requirements or the more mundane requirements for tax exemption. In all these cases a further linkage of these factors to socioeconomic status would have to be postulated, probably through the intermediacy of the kind of physician and hospital used for obstetrical care. If it is generally true, as Schlesinger and associates have shown in Onondaga County, that the degree of correspondence between hospital records and vital reports is quite close for the mortalities in which we are interested, further studies may have to include direct observation of newborn infants by a third party.

A second hypothesis that might be proposed to explain the differences between stillbirths and first-week deaths in their relationships to socioeconomic status is the occurrence of what might be called "deferred death." Baumgartner (*22*) has pointed out that in New York City in 1938 the fetal (28 weeks and over) death ratio was 31 percent greater than the death rate among infants under 1 week of age. In 1949 the fetal death ratio was somewhat lower than the hebdomadal death rate. Baumgartner postulated tentatively that "The progress in bringing a viable fetus to term or through successful delivery prior to term has produced more live-born infants subject to the effect of this change of state. This has seemed to have a retarding effect upon improvement in the neonatal mortality rate. Such a hypothesis presumes that those additional fetuses which are now brought to live birth constitute poorer risks, and does provide one reasonable explanation for the difficulties which are met in reducing the neonatal mortality rate." Our adaptation of this hypothesis would propose that there is much in common in the causes of death during the immediate prenatal and postnatal periods. The differences observed in the relationships of stillbirths and hebdomadal deaths to socioeconomic status are simply due to the fact that in the higher socioeconomic groups more fetuses with biologically poor equipment are born alive only to die soon after birth.

Table 3. Live births, stillbirths, and detailed hebdomadal deaths in five groups of census tracts arranged in ascending order of stillbirth ratio, Metropolitan Boston study area, 1950–54

Census tracts	Live births	Still-births	Deaths that occurred during—			
			0 day	1–2 days	3–6 days	0–6 days
	Number					
A	7,952	63	77	38	18	133
B	10,885	131	106	56	21	183
C	11,383	173	104	54	29	187
D	9,518	183	89	47	15	151
E	10,201	284	91	78	29	198
		Ratio [1]	Rate [1]			
A		7.9	9.7	4.8	2.3	16.7
B		12.0	9.7	5.1	1.9	16.8
C		15.2	9.1	4.7	2.5	16.4
D		19.2	9.4	4.9	1.6	15.9
E		27.8	8.9	7.6	2.8	19.4

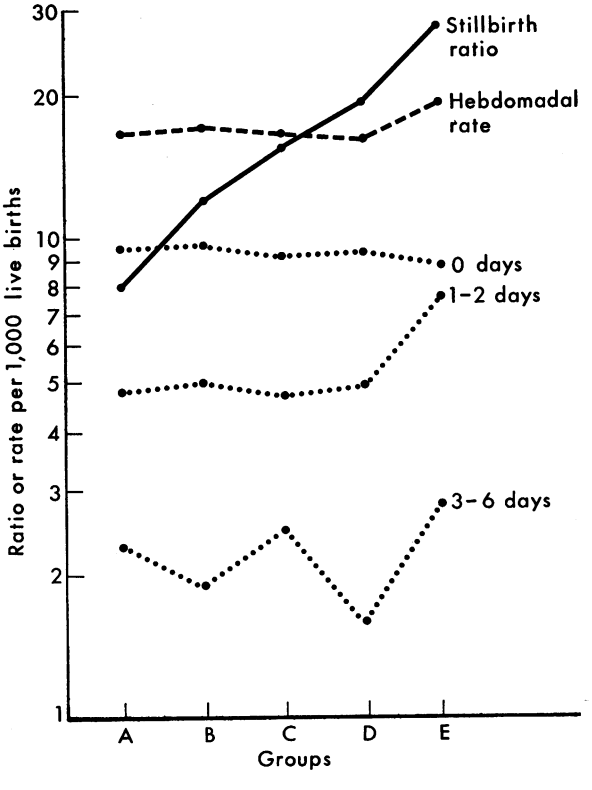
[1] Per 1,000 live births.

A third hypothesis is that because the causes of death in the prenatal and postnatal periods are not significantly alike they respond differently to the factors of mortality associated with the socioeconomic status. There is some epidemiologic evidence that this may be so. It is well known, for example, that factors such as maternal age and parity influence these mortalities somewhat differently (*32*, *33*). Since these variables are themselves related to socioeconomic status, they need to be accounted for in further studies of the relationships between socioeconomic status and fetal and infant mortality.

We attempted to carry the epidemiologic analysis of our material one step further, hoping to test the validity of the three hypotheses proposed above. To do this, the census tracts of the study area were arranged in order of ascending stillbirth ratio and divided into five groups with an approximately equal number of live births in each. Rates for deaths during 0 day, 1 through 2 days, and 3 through 6 days were computed (table 3 and fig. 5). Comparison showed the distribution of stillbirth ratios to be materially different from hebdomadal death rates as well as from each of the three component rates. (For stillbirth ratio and 0-day rates, $P<0.0001$; for stillbirth ratio and 1- through 2-day death rates, P between 0.01 and 0.0001; for stillbirth ratio and 3- through 6-day death rates, P between 0.01 and 0.0001). The conclusion that seems to follow from these comparisons is that errors of misclassification are not a likely explanation of the findings observed. Faulty classification would be expected to operate shortly after birth and not throughout the first week as our results indicate. The alternative is the existence of biologically determined factors based either on the operation of the mechanism of "deferred death," or a disparity in causes of death, or both.

Dunham and co-workers (*34*) pointed out many years ago that 42 percent of stillbirths (20 weeks or more) in hospitals occur during

Figure 5. Stillbirth ratio, hebdomadal death rate, and mortality rates for subdivisions of the first week, in five groups of census tracts arranged in ascending order of stillbirth ratio, Metropolitan Boston study area, 1950–54



labor. More recently, Baird and co-workers (*35*) suggested that the designation "obstetric deaths" be used to describe stillbirths and first-week deaths together since, in their opinion, "Nearly all can be attributed to causes present during intrauterine life or resulting from the process of birth, and it is often a matter of chance whether an infant dies just before or shortly after delivery; prevention is usually therefore the responsibility of the obstetrician." Potter and Jack (*18*) also said: ". . . it is evident that the fate of the mother, of the fetus before birth and the infant after birth are part of an inseparable whole and any effort toward bettering the condition of one will be reflected in the condition of the others . . . The majority of infections affecting the newborn are acquired before birth, and their prevention is also the province of the obstetrician."

From these studies, we might conclude that certain important causes of mortality operate in continuous fashion before, during, and after the process of birth. Therefore, the hypothesis of "deferred death" becomes more plausible. We cannot exclude, however, the existence of enough differences in the causes of death or their relative importance, or both, to produce different behavior with respect to socioeconomic variables. Dunham and associates (*34*), for example, showed that there were two conditions associated with stillbirth, one of which (birth injury) was operative during the process of birth but not before, and the other ("cord complication or anomaly") which was appreciably more frequent as a cause of intrapartum than prepartum death. On the other hand, congenital malformations and syphilis were more often associated with prepartum deaths.

Discussion

The findings of this study point out once again (*a*) the nature and magnitude of the task to be performed so that the public will benefit from current knowledge about the prevention of infant mortality, and (*b*) the need for greater understanding of the manner in which, and the mechanisms through which, socioeconomic status influences fetal and infant deaths.

Although our data are 10 years old, they are still pertinent today. Social and health problems in general and infant mortality in particular, far from becoming less pressing in our larger cities, have recently become even more ominous. We have already referred to the disquieting trends of infant mortality in urban areas. As Tayback and Wallace (*36*) clearly pointed out, in many of our larger cities demographic, social, and economic changes have occurred which have increased the need and demand for personal health services to be provided by health departments and reduced the financial capacity of the city to provide such services. Lesser recently presented a sobering summary of the situation (*37*). The following is only one of the many examples he gave: "From various parts of the country we learn that in Atlanta, 23 percent of women delivered at the Grady Hospital had had no prenatal care; in Dallas, approximately one-third of low-income patients received no prenatal care; at the Los Angeles County Hospital in 1958, it was 20 percent; at the D.C. General Hospital in Washington, it is 45 percent; and in the Bedford Stuyvesant section of Brooklyn, New York, it is 41 percent with no or little prenatal care."

The usefulness of the method of social area analysis in describing and locating social and health problems has been demonstrated by many studies similar to ours. We would merely like to point out once again that repeated studies of this nature, performed at suitable intervals, may be a most valuable tool for keeping track of important changes as they occur in our fast-altering cities.

With respect to the second objective, of understanding the factors that affect fetal and infant mortality and their linkage to socioeconomic status, our claims are quite modest. We have shown that the method is useful in raising questions and suggesting possible explanations. The complete answers will be forthcoming only through the appropriate combination of epidemiologic, clinical, and experimental studies.

Several additional studies are suggested by our findings. Similar studies are necessary in several cities to obtain confirmation or rebuttal of these findings. Repetitions in the same study area, using the same methods, might be especially illuminating. Where data permit, a comparison between stillbirth ratios and rates

for deaths during the first hour of life might be revealing. To improve the quality of the data available for study, there is need for more complete reporting of fetal deaths and a finer breakdown of fetal and infant mortality into component segments. Prepartum, intrapartum, and postpartum deaths may need sharper distinction in future epidemiologic studies. More reliable estimates of socioeconomic status might be obtained from the father's occupation, which appears on the standard live birth and stillbirth certificates. The inclusion of the father's occupation on the infant death report and of additional socioeconomic information, such as the parents' education, on pertinent vital records might be considered.

The confirmation of hypotheses, such as we have suggested, requires a careful prospective study of samples of stillbirths and hebdomadal deaths. Misclassification on the scale necessary to produce the reported findings should not be difficult to identify. A study of the physical condition at the time of delivery of samples of live-born infants from various socioeconomic groups might confirm or deny the suggestion that, in the higher socioeconomic groups, a proportion of children are delivered alive but in such poor condition that they almost inevitably expire soon after birth.

Summary

Data were obtained on the socioeconomic characteristics (1950 census) of 90 census tracts in a segment of Metropolitan Boston designated as the study area and the fetal and infant deaths occurring to mothers who resided in those tracts. These were used (*a*) to plot the geographic distribution of perinatal mortality in the study area, and (*b*) to study the relationships between the various mortality rates and socioeconomic status.

The findings show a fivefold difference in perinatal mortality between the census tracts with the highest and the lowest socioeconomic status, and a sharp geographic localization of the areas of highest mortality. In the census tracts with the highest mortality, the component segments of infant mortality were proportionately related to one another in a manner similar to the pattern in partially developed countries today and of the United States as a whole several decades ago.

All segments of mortality decreased markedly as socioeconomic status improved, except for deaths during the first week of life which remained at an even level. Analysis of the data suggests that a systematic misclassification of stillbirths as first-week deaths (or the reverse) is the least likely explanation, and the deferral of perinatal deaths among the high socioeconomic groups the most likely explanation of the findings.

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