INFANT MORTALITY AND SOCIO-ECONOMIC STATUS: A CHANGING RELATIONSHIP

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THE primary causes of the enormous mortality decline characterizing the recent demographic history of the United States (and other economically developed countries) lie in the fact that we have achieved a higher level of living than our ancestors. As a result of improved economic conditions, and research in medicine and sanitation, the people of the Western world have gained an unprecedented measure of control over those infectious diseases which until quite recently took such a heavy toll, particularly among the younger elements of the population. This is clearly evidenced by the fact that one of the most significant mortality trends of the present century has been an extremely pronounced decline in the rate at which deaths occur to the population under one year of age. In the United States, for example, as compared to a 55 per cent reduction in the total death rate between 1900 and 1957, the infant mortality rate during the same period declined by 82 per cent.[3]

In the past, the decline in infant mortality was so marked as soon as a nation began to undergo economic development that the infant mortality rate came to be looked upon as the most sensitive index of level of living and sanitary conditions that

[3] Age-specific death rates for 1957 are published in: National Office of Vital Statistics, VITAL STATISTICS OF THE UNITED STATES, 1957, Vol. I (Washington, D. C.: U. S. Government Printing Office, 1959) Table CG, p. cxvii. Comparable data for 1900 may be found in: National Office of Vital Statistics, Analysis and Summary Tables, VITAL STATISTICS OF THE UNITED STATES, 1950, Vol. I (Washington, D. C.: U. S. Government Printing Office, 1954). Table 8.19, p. 161.

we possessed.[4] As such, it was often used as a means of comparing the relative levels of social and economic well-being characterizing different countries.[5] Since infant mortality was such an extremely sensitive index of economic differences among countries, one would logically expect it to have been equally sensitive to economic differences that existed among different segments of the population within a single country; and so it was. Writing in England nearly a half-century ago, Sir Arthur Newsholme stated that:

> No fact is better established than that the death rate, and especially the death rate among children, is high in inverse proportion to the social status of the population.[6]

Similarly, in summing up his classic study of infant mortality in the United States during the first quarter of the twentieth century, Robert M. Woodbury noted that the infant death rates were "highest when the father's earnings were low and lowest when the father's earnings were relatively high."[7] Although Woodbury's findings suggested that there were several other variables which bore a causal relation to levels of infant mortality (e.g., race, physical condition of the mother, age of mother, type of feeding, length of interval between pregnancies), all of these other factors were found to be highly correlated with the earnings of the father. Thus, in summing up the interrelationship between infant mortality, father's income, and the other causative factors, he concluded:

> The analysis indicated that low earnings of the father exerted a potent influence over the prevalence of these factors and therefore must be regarded as primarily responsible for the greater

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[4] The extreme sensitivity of the infant mortality rate to differences in socio-economic status was noted by Newsholme a half-century ago *in:* Infant and Child Mortality, Report C d 5263, SUPPLEMENT TO THE THIRTY-NINTH ANNUAL REPORT OF THE LOCAL GOVERNMENT BOARD, (London: Darling and Son, Ltd., 1910).

[5] Dennis Wrong, POPULATION, (New York: Random House, 1956), pp. 36–38.

[6] Arthur Newsholme, THIRTY-NINTH ANNUAL REPORT OF THE LOCAL GOVERNMENT BOARD, Report C d 5312 (London, Darling and Son, Ltd., 1910), p. 28.

[7] Robert M. Woodbury, CASUAL FACTORS IN INFANT MORTALITY, (United States Department of Labor, Children's Bureau Publication No. 142): [Washington, D.C.: U. S. Government Printing Office, 1925] p. 8.

mortality associated with them. The presence of intermediate factors in the chain of causation does not lessen the responsibility of low earnings as a primary cause.[8]

As was true in the past, it can be shown that the infant mortality rate is still a very useful measure for ranking whole countries relative to one another in terms of their overall levels of social and economic well-being.[9] However, there seems to be some question as to whether or not infant mortality continues to be such a sensitive index of differences in socio-economic status within a country like the United States where the mortality of the population under one year of age has been brought fairly well under control. The infant mortality rate in this country has declined steadily from 99.9 per 1,000 live births in 1915 to a low of 26.0 in 1956,[10] but conflicting evidence exists pertaining to the extent to which this reduction in time has uniformly characterized all segments of the population and all socio-economic groups within the urban community. That is, there appears to be some disagreement as to the extent to which differences in socio-economic status are characterized by differences in infant mortality. On the one hand, Ellis has shown that the rate at which infants succumb to a premature death bears a strong inverse relationship to socio-economic status in Houston, Texas.[11] On the other hand, Willie has found that such an association is virtually non-existent in Syracuse, New York.[12] Part of this disagreement may be due to actual differences that exist between the population groups studied;[13]

[8] *Ibid.*, p. 9.

[9] Edward G. Stockwell, The Measurement of Economic Development, *Economic Development and Cultural Change*, VIII, 4 (July, 1960), Part I, pp. 419–432.

[10] Donald J. Bogue, THE POPULATION OF THE UNITED STATES, (Glencoe: Illinois, The Free Press, 1959), Tables 9–17, p. 207.

[11] John M. Ellis, "Mortality in Houston, Texas, 1949–1951: A Study of Socio-Economic Differentials," (Unpublished Ph.D. dissertation. [Department of Sociology, University of Texas, 1956]), p. 158.

[12] Charles V. Willie, A Research Note on the Changing Association Between Infant Mortality and Socio-Economic Status, *Social Forces*, XXXVII, 3 (March, 1959), pp. 221–227.

[13] For a discussion of the way in which the relationship between infant and total mortality and socio-economic status may be influenced by the nature of the city

part may be due to the use of different methodological proce-
dures.[14] In either case, such conflicting findings are certainly
indicative of the need for additional research in this area.

Data and Methods. The study reported on in this paper,
which seeks to throw additional light on this question of the
relationship between socio-economic status and infant mor-
tality, is based on data for the city of Providence, Rhode Island.
The study population consisted of all live-born infants under
one year of age who died between January 1, 1949, and Decem-
ber 31, 1951, and all live births in the year 1950. Infant mortal-
ity rates were computed by relating the average number of
deaths occurring annually during the three years 1949–51 to the
total number of live births in 1950. The census tract of mother's
usual residence is the basic unit of analysis.[15] The extent to
which the incidence of infant deaths is related to socio-economic
status was examined using two alternative methodological ap-
proaches:

> 1. *Social Area Analysis.* This approach examines variations
> in infant mortality among census tracts that have been grouped
> into five socio-economic areas so that approximately 20 per
> cent of the tracts fell into each area. The method of grouping
> tracts, the one employed by Ellis in the Houston study,[16] is
> a modification of the social rank index developed by Eshref
> Shevky and Marilyn Williams in their study of the social areas
> of Los Angeles.[17] This index is a composite measure of three
> socio-economic indices computed separately for each census

studied, the reader is referred to the author's Ph.D. dissertation cited above, espe-
cially to Chapters 4–6.

[14] Willie, on the one hand, first grouped the Syracuse census tracts into high and
low sectors according to infant mortality and then used a correlation analysis to re-
late infant mortality to various measures of socio-economic status. Ellis, on the other
hand, studied the mortality of Houston in terms of five broad socio-economic areas
delimited on the occupational, educational and income composition of census tracts.

[15] For a brief discussion of the relative merits and limitations of using census
tracts as the basic unit for analyzing the differential distribution of vital events
within urban populations, see Chapter 3 of the author's unpublished Ph.D. disserta-
tion, *op. cit.,* pp. 86–92.

[16] Ellis, *op. cit.*

[17] Eshref Shevky, and Marilyn Williams, THE SOCIAL AREAS OF LOS ANGELES:
ANALYSIS AND TYPOLOGY, (Berkeley and Los Angeles: University of California
Press, 1949).

Social Rank Areas	Infant Mortality	Neonatal Mortality	Postneonatal Mortality
All Areas	28.2	22.8	5.4
I (High)	31.5	27.2	4.3
II	30.3	26.7	3.7
III	24.0	18.2	5.9
IV	29.5	22.9	6.6
V (Low)	25.9	19.9	6.0

Table 1. Infant, neonatal and postneonatal mortality for the five social rank areas of Providence, Rhode Island: 1949–1951. (Deaths per 1,000 live births.)

tract (i.e., occupation, education and income), and can be defined as the arithmetic mean of their percentile scores.

2. *Correlation Analysis.* In the second approach, rank correlation coefficients (Kendall's *tau*)[18] between 36 census tract mortality rates and five indices of socio-economic status were computed.[19]

Results of the Analysis. As can be seen in Table 1, an erratic pattern emerges when total infant mortality is examined for the social rank areas. Furthermore, the complete absence of even a tendency toward an inverse association between infant mortality and social rank is demonstrated most emphatically by the fact that Area I, the area having the highest socio-economic status, is characterized by the highest infant mortality rate. The rate of 31.5 per 1,000 live births observed in Area I exceeds the lowest rate (24.0 in Area III) by 31 per cent, and exceeds the infant death rate of the lowest social rank area (25.9 per 1,000 live births) by approximately 22 per cent. On

[18] Maurice G. Kendall, Rank Correlation Methods, (London: Charles Griffin, 1948).

[19] The five measures of the socio-economic status of census tracts that were used included the three measures related in the social rank index, plus two measures of housing characteristics. These measures may be defined as follows: (1) *occupation*, the number of craftsmen, operatives and laborers per 1,000 employed persons; (2) *education*, the number of persons per 1,000 age 25 or over having less than 8 years of schooling; (3) *income*, census tract median income of families and unrelated individuals; (4) *rent*, the median monthly contract rent of dwelling units; (5) *crowding*, the number of dwelling units containing 1.01 or more persons per room per 1,000 dwelling units. For a more complete description and evaluation of the research procedures see Edward G. Stockwell, "Socio-Economic Mortality Differentials . . .," pp. 78–92.

the basis of these data, then, it can be concluded that, when the social area analysis approach is used, there is no discernible pattern to the association between infant mortality and socio-economic status in Providence.

Although there is evidently no relationship between socio-economic status and total infant mortality in Providence, a decidedly different picture emerges when age of infants at death is taken into consideration. For purposes of this analysis, infant mortality has been divided into two categories: neonatal mortality (deaths occurring during the first month of life), and postneonatal mortality (deaths occurring between the ages of one month and one year). These data, which are also presented in Table 1, show that the inverse association still characterizes the postneonatal group. In contrast to the neonatal death rates, where a direct association is approximated (e.g., the rates in Area I and Area II are, on the average, 33 per cent greater than the rates in the lower social rank areas), the postneonatal death rates tend to increase as socio-economic status decreases. Although a consistent inverse gradient is absent, and although the absolute difference in death rates among the various groups is small, the adverse effects of a low socio-economic status on mortality after the first month of life are readily apparent; the postneonatal death rates in Area I and Area II are exceeded by the corresponding rates in the three lower social rank areas by from 37 per cent (Area III over Area I), to 80 per cent (Area IV over Area II).

The detrimental effects of a low socio-economic status on levels of mortality after the first month of life can be seen more clearly when the mortality experience of the two highest social rank areas is compared to that of the three lowest ranking areas. To illustrate, the *combined* postneonatal death rate of Areas III, IV, and V is found to be 6.2 per 1,000 live births, which is 55 per cent greater than the *combined* rate for Area I and Area II (4.0 per 1,000 live births).

The existence of an approximate inverse relationship to socio-economic status for postneonatal mortality but not for total

infant mortality is very likely a reflection of the progress made
by medical science in combatting the infectious causes of death.
As noted above, the overall reduction of infant mortality has
been due largely to an increasing control over infection. Today
the infectious diseases have been replaced as the leading causes
of infant mortality by those causes more directly associated
with the process of birth.[20] This is aptly illustrated by the fact
that birth injuries and immaturity accounted for nearly 65
per cent of all infant deaths in Providence during the period
1949–51. Moreover, the addition of deaths due to these causes
to those associated with congenital malformations accounts
for approximately 80 per cent of the deaths occurring to per-
sons under one year of age. Of the remaining 20 per cent, only
6 per cent were attributed to infectious causes (e.g., enteritis,
tuberculosis, pneumonia of the new born), while 14 per cent
were distributed among a wide variety of causes (lukemia,
rheumatic heart disease, accidents, etc.). Since those causes
that accounted for 80 per cent of all infant deaths are primarily
biological in nature, it is not surprising that there is a lack of
any clear-cut association between socio-economic status and
infant mortality.

It may be that the approximate inverse association noted for
postneonatal mortality can be attributed to the lesser role
played by those causes that are associated with the process of
birth. Although the lack of a sufficient number of cases in
several categories prevented a cause-specific analysis for causes
other than the two leading ones, an examination of Table 2
serves to point out the lack of any clear-cut association be-
tween socio-conomic status and infant mortality for either
congenital malformations or for deaths due to birth injuries or
immaturity. On the one hand, the lowest death rate for
congenital malformations (2.6 per 1,000 live births) is found
to characterize Area V, whereas the highest rate (6.6 per 1,000
live births) is found in the highest social rank area. On the

[20] Iwao M. Moriyama, Recent Change in Infant Mortality Trend, *Public Health Reports*, LXXV, 5 (May, 1960), pp. 391–405.

Social Rank Areas	Birth Injuries and Immaturity	Congenital Malformations
All Areas	18.9	4.2
I (High)	18.0	6.6
II	24.6	3.7
III	15.5	3.3
IV	18.4	4.9
V (Low)	18.2	2.6

Table 2. Infant mortality rates for deaths due to birth injuries and immaturity, and for deaths due to congenital malformations, for the five social rank areas of Providence, Rhode Island: 1949–1951. (Deaths per 1,000 live births.)

other hand, for the deaths due to birth injuries or immaturity, the lowest death rate is found in Area III (15.5); the highest is found in Area II (24.6), while very little variation is observed for the highest and two lowest social rank areas.

When the preceding observations are viewed in conjunction with the fact that these two cause groups accounted for approximately 75 per cent of all neonatal deaths, but only 38 per cent of the postneonatal deaths in Providence, the inverse association with socio-economic status approximated for the latter group becomes more readily understandable. Among infants who survived the first month of life, the majority of deaths are ascribed to causes which are largely unrelated to the physiological processes of gestation and birth and which are therefore more likely to be influenced by environmental conditions.[21] In Providence, 58 per cent of the deaths occurring to infants after the first month of life were attributed to either infectious causes such as acute bronchitis, pneumonia and diarrhea of the new born (40 per cent), or to accidental causes such as suffocation and poisoning (18 per cent). Since deaths from these causes can largely be

[21] In discussing the reduction of mortality through the amelioration of adverse social and economic environmental conditions, the United Nations has stressed that the greatest progress for mortality has been realized after the first month of life. By contrast, relatively little progress has been made in reducing neonatal mortality, which is affected more directly by biological factors than by socio-economic influences. Department of Social Affairs, Population Division, United Nations, *The Determinants and Consequencies of Population Trends,* ST/SOA/Series A/17, (New York: Lake Success, January, 1953), p. 65.

regarded as "preventable," it is clear that the extent of un-
necessary reproductive wastage is greater among persons living
in the lower social rank areas that it is among persons living in
the areas characterized by a more favorable social and economic
environment. That is, the lack of any clear-cut inverse as-
sociation when total infant mortality is considered may be ex-
plained by the fact that the majority of deaths under one year
of age (80 per cent) occurred during the first month of life,
the period during which the influence of biological factors is
greatest. On the other hand, the approximate inverse relation-
ship observed for infants dying between the ages of one month
and one year likely reflects the lesser role played by these
causes that are associated with the physiological processes of
birth and gestation, and the greater role of environmental
factors.

Turning to the second phase of the research, the results of
the correlation analysis which are presented in Table 3 tended
to confirm the conclusion, derived from the social area analysis,
that infant mortality does not appear to be related to socio-
economic status in Providence, Rhode Island. In contrast to
mortality for all ages, where a pronounced inverse association
was found to characterize all five of the socio-economic indices
examined, three of the indices (occupation, education and
rent) were actually found to bear a positive association
(though not statistically significant), to census tract varia-
tions in `infant mortality. Moreover, of the remaining two

Table 3. Rank correlation coefficients between mortality and five indices of
socio-economic status for all deaths and for infant deaths in Providence, Rhode
Island: 1949–1951.

Socio-Economic Indices	Total Mortality	Infant Mortality
Occupation	−.25	+.11*
Education	−.39	+.03*
Income	−.45	−.23
Rent	−.29	+.10*
Crowding	−.36	−.17*

* Not significant at five per cent.

measures that were inversely related to infant mortality (income and the extent of overcrowding in dwelling units), only income yielded a statistically significant association. This finding, that there is a significant correlation between infant mortality and income in Providence, but not for any of the other socio-economic variables is consistent with the results of Willie's study in Syracuse, New York.[22] Furthermore, the existence of a socio-economic differential for total but not for infant mortality may be taken as evidence in support of his conclusion that infant mortality differs markedly from other phases of mortality in the degree to which it reflects differences in socio-economic status.

Summary and Conclusions. On the basis of the findings of the present study, it is apparent that, at least in one city, infant mortality is no longer the extremely sensitive index of differences in socio-economic status that it was in the past. The erratic pattern that was observed when total infant mortality was related to socio-economic status was found to be a reflection of the fact that the majority of the deaths under one year of age today occur during the first few hours or days of life, and are due to causes that are associated with biological rather than socio-economic factors. On the other hand, for those few deaths that take place between the ages of one month and one year, where the major causes of death are farther removed from the physiological processes of gestation and birth, infant mortality continues to be inversely related to differences in socio-economic status.

In a rapidly changing society such as ours, we are constantly being faced with the necessity of revising old theories and bringing them up to date with changes occurring in the social order. The data presented in the preceding paragraphs suggest that we might now be at a point where it is time to reconsider the assumption pertaining to the infant mortality rate being the most sensitive index we possess of the level of social and economic well-being characterizing a given population group.

22 Willie, *op. cit.*

Although this may still be true on an international level,[23] the evidence presented here, and in the earlier study by Willie,[24] indicate that it is apparently no longer true in modern urban-industrial society—certainly not true to the extent that it was in the past. The decline in the significance of infant mortality as an index of social and economic well-being within a country such as the United States gives ample testimony to the success of public health measures and the effectiveness of improved medical techniques in combating the major infectious causes of death. Moreover, as these efforts continue, it may well be that the approximate inverse relationship noted between socio-economic status and postneonatal mortality (where the infectious diseases continue to take the heaviest toll), will eventually be eliminated. Should this be the case, the future could see an even greater decline in the significance of infant mortality as an index of socio-economic status.

[23] Stockwell, The Measurement of Economic Development, *op. cit.*
[24] Willie, *op. cit.*