i

TRENDS IN THE RELATIONSHIP BETWEEN INFANT MORTALITY AND
SOCIOECONOMIC STATUS: 1950, 1960 AND 1970

Donald J. Adamchak

A Dissertation

Submitted to the Graduate College of Bowling Green
State University in partial fulfillment of
the requirements for the degree of

DOCTOR OF PHILOSOPHY

June 1978

Approved by Doctoral Committee

Ed. K. K. K. Advisor
Department of Sociology

Carol G. Spill
Graduate College Representative

Karl Sell

Joseph B. Kervz, Jr.

St. Modestus

378.771

B7do

ii

no. 484

ABSTRACT

The infant mortality/socioeconomic status relationship was examined in the city of Toledo, Ohio for the years centering around 1950, 1960 and 1970. Data were obtained from the Office of Vital Statistics, Toledo Department of Health; the Ohio Department of Health; and the 1950, 1960 and 1970 Censuses of Population and Housing. Several selected economic, family and housing status characteristics were investigated longitudinally in relation to total infant, neonatal and postneonatal mortality in order to ascertain the nature and extent of changes that have taken place in this traditionally inverse relationship.

Findings indicated that the traditional inverse relationship is pronounced, and that it widened from 1950 to 1970 for the total and nonwhite populations. The relationship widened from 1950 to 1960 for the white population, but remained fairly stable and even declined in some cases from 1960 to 1970. The overall widening infant mortality/socioeconomic status relationship resulted from an increasing inverse neonatal pattern which was contrary to several studies conducted a decade ago. This increasing inverse neonatal pattern was due in part to a "cause-period cross-over effect"; that is, exogeneous causes of death have started to contribute more to deaths in the neonatal period.

Further examination of these data suggested that the status variables the differentials were working through have shifted from one time period to another. In 1950, economic status was primarily responsible; in 1960, it was economic status and housing status; and in 1970, family status and economic status predominated.

These findings were interpreted as providing additional support for the contention that the inverse infant mortality/socioeconomic status relationship is still markedly pronounced in American society; and as new social phenomena emerge (e.g., increasing marital instability) they appear to be very sensitive to this indicator of the social and economic well-being of our population. In addition, the suggestion was advanced that in future research special attention be given to cause of death in relation to period of death, as well as to the influence of family type variables on levels of infant mortality.

ACKNOWLEDGEMENTS

It would be impossible to acknowledge the extent of family, friends, peers and teachers who have contributed to my education and thus to this dissertation. Nevertheless, I wish to thank the members of my dissertation committee, Professors Theodore Groat, Joseph Perry, Richard Zeller and Joseph Spinelli for their valuable substantive as well as editorial assistance. A special thanks is also extended to Dr. Jerry Wicks for his help in preparing part of the data for analysis.

I also wish to thank Robert Siegel and his staff, whose assistance and cooperation enabled me to collect these data from the Office of Vital Statistics, Toledo Department of Health.

Special appreciation is extended to my major advisor, Dr. Edward G. Stockwell, for his support and encouragement throughout the entire research process.

Finally, I would like to dedicate the dissertation to my wife Phyllis, who endured a great deal during the past three years.

TABLE OF CONTENTS

	Page
ABSTRACT	ii
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	vi
LIST OF FIGURES	xii
Chapter	
I. INTRODUCTION AND RESEARCH PROBLEM.	1
Research Problem	2
Data and Methods	6
Purpose of Study	7
Plan of Presentation	9
II. RESEARCH ON SOCIOECONOMIC MORTALITY DIFFERENTIALS IN THE UNITED STATES.	10
Research on Mortality and Socioeconomic Status.	14
Research on Infant Mortality and Socioeconomic Status.	29
Research Prior to 1950.	30
Research From 1950 to 1960.	36
Research Since 1960	42
Summary, Discussion and Hypotheses	60
III. RESEARCH METHODOLOGY	66
The Study City	66
Sources of Data.	71
Variable Description	72
Research Procedures and Statistical Analysis	74
Description of the Social Area Ranking Procedure.	78
Correlation Analysis.	79
Limitations of the Study	84
IV. FINDINGS OF THE INVESTIGATION BETWEEN INFANT MORTALITY AND SOCIOECONOMIC STATUS.	88
Social Area Ranking.	90
Economic Status Rankings.	90
Family Status Rankings.	108
Housing Status Rankings	123

Cause of Death Types.	134
Summary and Discussion.	140
Correlational Analysis	149
Summary and Discussion.	168
V. SUMMARY AND CONCLUSIONS.	172
Review of Hypotheses.	172
Implications	177
Future Research.	181
BIBLIOGRAPHY	183

LIST OF TABLES

Table	page
1. Age-Standardized Average Annual Death Rates Per 1,000 Population for Five Social Rank Areas, White Population by Sex, for Various Cities and Dates . . .	24
2. Age-Specific White Death Rates, by Sex, for Highest and Lowest Social Rank Areas in Phoenix, 1970 . . .	25
3. Age-Standardized Death Rates of Nonwhites, for High and Low Social Rank Areas, for Various Cities and Dates	26
4. Infant Mortality Rate, Massachusetts, 1851-54 to 1950-54.	32
5. Infant Mortality in Economic Areas of Toledo, Ohio: 1970	52
6. Infant Mortality in Four Groups of Census Tracts Ranked by Median Family Income and Occupational Structure: San Antonio, 1970-74.	54
7. Infant Mortality Rates by Age and Color: United States, 1950 and 1960-73.	58
8. Estimated Average Annual Number of Infant Deaths Per 1,000 Legitimate Live Births, by Race, Family Income, and Parental Education: United States, 1964-66	59
9. Selected Demographic and Socioeconomic Characteristics of Toledo, Ohio: 1950, 1960, and 1970.	69
10. Selected Socioeconomic Characteristics of Toledo, Ohio, the State of Ohio and the United States: 1970.	70
11. Infant, Neonatal and Postneonatal Mortality Rates and Component Percentages: Toledo, Ohio, 1950, 1960, and 1970.	89
12. Infant, Neonatal and Postneonatal Mortality Rates by Percent Age 25 and Over with a High School Education: Total Population, Toledo, Ohio, 1950, 1960 and 1970	92
13. Infant, Neonatal and Postneonatal Mortality Rates by Percent Age 25 and Over with a High School Education: White Population, Toledo, Ohio, 1950 1960 and 1970	93

14. Infant Mortality Rates by Percent Age 25 and Over with a High School Education: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	94
15. Neonatal Mortality Rates by Percent Age 25 and Over with a High School Education: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	95
16. Postneonatal Mortality Rates by Percent Age 25 and Over with a High School Education: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	96
17. Infant, Neonatal and Postneonatal Mortality Rates by Percent of Labor Force Engaged in White Collar Occupations: Total Population, Toledo, Ohio, 1950, 1960 and 1970	98
18. Infant, Neonatal and Postneonatal Mortality Rates by Percent of Labor Force Engaged in White Collar Occupations: White Population, Toledo, Ohio, 1950, 1960 and 1970	99
19. Infant Mortality Rates by Percent of Labor Force Engaged in White Collar Occupations: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	100
20. Neonatal Mortality Rates by Percent of Labor Force Engaged in White Collar Occupations: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	101
21. Postneonatal Mortality Rates by Percent of Labor Force Engaged in White Collar Occupations: Total and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	102
22. Infant, Neonatal and Postneonatal Mortality Rates by Median Family Income Groupings: Total Population, Toledo, Ohio, 1950, 1960 and 1970	103
23. Infant, Neonatal and Postneonatal Mortality Rates by Median Family Income Groupings: White Population, Toledo, Ohio, 1950, 1960 and 1970	104
24. Infant Mortality Rates by Median Family Income Groupings: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	105

25. Neonatal Mortality Rates by Median Family Income Groupings: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.106
26. Postneonatal Mortality Rates by Median Family Income Groupings: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.107
27. Infant, Neonatal and Postneonatal Mortality Rates by Percent Unemployed: Total Population, Toledo, Ohio, 1950, 1960 and 1970	.109
28. Infant, Neonatal and Postneonatal Mortality Rates by Percent Unemployed: White Population, Toledo, Ohio, 1950, 1960 and 1970	.110
29. Infant Mortality Rates by Percent Unemployed: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.111
30. Neonatal Mortality Rates by Percent Unemployed: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.112
31. Postneonatal Mortality Rates by Percent Unemployed: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.113
32. Infant, Neonatal and Postneonatal Mortality Rates by Percent Female Labor Force Participation: Total Population, Toledo, Ohio, 1950, 1960 and 1970	.115
33. Infant, Neonatal and Postneonatal Mortality Rates by Percent Female Labor Force Participation: White Population, Toledo, Ohio, 1950, 1960 and 1970	.117
34. Infant, Neonatal and Postneonatal Mortality Rates by Percent Age 14 and Over Widowed or Divorced: Total Population, Toledo, Ohio, 1950, 1960 and 1970	.118
35. Infant, Neonatal and Postneonatal Mortality Rates by Percent Age 14 and Over Widowed or Divorced: White Population, Toledo, Ohio, 1950, 1960 and 1970	.119
36. Infant Mortality Rates by Percent Age 14 and Over Widowed or Divorced: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.120
37. Neonatal Mortality Rates by Percent Age 14 and Over Widowed or Divorced: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.121

38. Postneonatal Mortality Rates by Percent Age 14 and Over Widowed or Divorced: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970122
39. Infant, Neonatal and Postneonatal Mortality Rates by Percent of Dwelling Units with 1.01 or More Persons Per Room: Total Population, Toledo, Ohio, 1950, 1960 and 1970124
40. Infant, Neonatal and Postneonatal Mortality Rates by Percent of Dwelling Units with 1.01 or More Persons Per Room: White Population, Toledo, Ohio, 1950, 1960 and 1970125
41. Infant Mortality Rates by Percent of Dwelling Units with 1.01 or More Persons Per Room: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970126
42. Neonatal Mortality Rates by Percent of Dwelling Units with 1.01 or More Persons Per Room: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970127
43. Postneonatal Mortality Rates by Percent of Dwelling Units with 1.01 or More Persons Per Room: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970128
44. Infant, Neonatal and Postneonatal Mortality Rates by Percent Single Housing Units: Total Population, Toledo, Ohio, 1950, 1960 and 1970129
45. Infant, Neonatal and Postneonatal Mortality Rates by Percent Single Housing Units: White Population, Toledo, Ohio, 1950, 1960 and 1970130
46. Infant Mortality Rates by Percent Single Housing Units: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970131
47. Neonatal Mortality Rates by Percent Single Housing Units: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970132
48. Postneonatal Mortality Rates by Percent Single Housing Units: Total, White and Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970133

49. Infant, Neonatal and Postneonatal Mortality Rates by Income Group and Cause of Death Type: White Population, Toledo, Ohio, 1950, 1960 and 1970	.137
50. Infant Mortality Component Percentages by Cause Type: White Population, Toledo, Ohio, 1950, 1960 and 1970	.138
51. Infant Mortality Cause and Period Percent Comparisons for the Total, White and Nonwhite Population: Toledo, Ohio, 1950, 1960 and 1970	.139
52. Infant, Neonatal and Postneonatal Mortality Ratios (Social Area IV: Social Area I): Total Population, Toledo, Ohio, 1950, 1960 and 1970	.142
53. Infant, Neonatal and Postneonatal Mortality Ratios (Social Area IV: Social Area I): White Population, Toledo, Ohio, 1950, 1960 and 1970	.143
54. Infant, Neonatal and Postneonatal Mortality Ratios (Social Area II: Social Area I): Nonwhite Population, Toledo, Ohio, 1950, 1960 and 1970	.146
55. Zero-Order Correlation Coefficients Between Infant, Neonatal and Postneonatal Mortality Rates and Selected Socioeconomic Measures: Toledo, Ohio, 1950, 1960 and 1970	.150
56. Squared Zero-Order, Squared Semipartial, and Squared Partial Correlation Coefficients for Infant Mortality with Socioeconomic Status Variables: Toledo, Ohio, 1950, 1960 and 1970.	.153
57. Squared Zero-Order, Squared Semipartial, and Squared Partial Correlation Coefficients for Neonatal Mortality with Socioeconomic Status Variables: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite Control for sr^2 and pr^2).	.154
58. Squared Zero-Order, Squared Semipartial, and Squared Partial Correlation Coefficients for Postneonatal Mortality with Socioeconomic Status Variables: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite Control for sr^2 and pr^2).	.155
59. Squared Semipartial Correlation Coefficients Between Infant, Neonatal and Postneonatal Mortality and Economic (E), Family (F) and Housing (H) Status: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite (B) Controlled)	.160

60. Dominating Variable Sets and Single Variables for Infant, Neonatal and Postneonatal Mortality: Toledo, Ohio, 1950, 1960 and 1970	.167
--	------

LIST OF FIGURES

Figure	page
1. Infant Mortality Rates by Color: United States, 1925-74	.57
2. Map of Ohio Showing the City of Toledo	.68
3. Census Tracts of Toledo, Ohio.	.77
4. Squared Semipartial Correlation Coefficients between Infant Mortality Rates and Socioeconomic Status Variables: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite Control).	159
5. Squared Semipartial Correlation Coefficients between Infant Mortality Rates and Economic (E), Family (F) and Housing (H) Status Variable Sets: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite (B) Control and Each Set Controlling on All Others). . .	163
6. Squared Semipartial Correlation Coefficients between Neonatal Mortality Rates and Economic (E), Family (F) and Housing (H) Status Variable Sets: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite (B) Control and Each Set Controlling On All Others). . .	164
7. Squared Semipartial Correlation Coefficients between Postneonatal Mortality Rates and Econo- mic (E), Family (F) and Housing (H) Status Variable Sets: Toledo, Ohio, 1950, 1960 and 1970 (Nonwhite (B) Control and Each Set Con- trolling On All Others).	165

CHAPTER I

INTRODUCTION AND RESEARCH PROBLEM

The infant mortality rate has historically been regarded as a very sensitive index of differences in the levels of social and economic well being among various population groups (Newsholme, 1910; Woodbury, 1925). Writing early in the present century, Newsholme (1910:28) stated that "infant mortality is the most sensitive index we possess of social welfare and of sanitary administration, especially under urban conditions." He also stated that the economic and social conditions prevailing in a population are inversely related to mortality levels in general, but especially to child mortality (1910:28):

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.

Over the years the infant mortality rate has remained relatively consistent and sensitive to socioeconomic differences on an international level. As Hauser noted (1959:101):

The infant mortality rate is a relatively sensitive indicator of differences in level of economic development. Historically, among the economically advanced nations, the earliest and greatest gains in improved mortality conditions were manifest in the relatively great reductions in deaths to persons under one year of age; and a similar pattern is discernible in the improving mortality conditions in the less developed areas of the world today.

Stockwell (1960a) went even further and suggested that the infant mortality rate was so strongly related to the economic status of nations that it could be used as an indirect index of level of economic development. Although numerous studies suggest that infant mortality continues to be highly sensitive to socioeconomic differences on an international level (Stockwell, 1966a, Ekanem, 1972; Stockwell and Hutchinson, 1975), a number of recent studies have raised questions concerning the precise status of this traditionally inverse relationship within an advanced, relatively low mortality country such as the United States (Willie, 1959; Stockwell, 1962a; Donabedian, 1965). These studies will be discussed more fully in the following section.

Research Problem

Although the traditional pattern has been one where infant mortality was inversely associated with levels of socioeconomic status, several recent studies have presented evidence to suggest that this relationship was changing in the United States. Among these is the study by Charles V. Willie (1959: 225-226) who found that "little association was demonstrated between infant mortality rates and the socio-economic status level of ecological areas in Syracuse, New York." Family income was significantly correlated with both the neonatal (first month of life) and the postneonatal (age one month to one year) components of infant mortality, whereas a composite socioeconomic index based on occupation, education

and housing variables was significantly associated with only the postneonatal mortality rates. On the basis of these observations, and since the vast majority of infant deaths in the United States occur during the neonatal period, Willie concluded that socioeconomic status factors appeared to exert little effect on the patterning of the distribution of total infant mortality rates.

Stockwell's (1962a) study of Providence, Rhode Island was consistent with Willie's findings. Of the five socioeconomic indexes used, only income exhibited a significant inverse relationship to infant mortality. However, infant mortality still appeared to be sensitive to differences in other components of socioeconomic status (e.g., occupation and education) when analysis was restricted to the post-neonatal component, or to that segment of infant mortality where the major causes of death are farther removed from the physiological processes of gestation and birth. Neonatal mortality, on the other hand, which accounted for the vast majority of infant deaths, and where the major causes of death were more directly associated with birth (e.g., birth injury, prematurity), displayed a random pattern when related to socioeconomic status. On the basis of this evidence Stockwell (1962a:110-111) concluded 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. . . . it may

well be that the approximate inverse relationship noted between socioeconomic 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 socioeconomic status.

Both of the preceding studies contained the implicit suggestion that where infant mortality was low, and where the major proportion of infant deaths take place during the neonatal period and are due to endogeneous causes (e.g., immaturity, birth injuries, congenital malformations, post-natal asphyxia) the traditional negative correlation between infant mortality and socioeconomic status would be blunted. This is because these causes are primarily physiological in origin and were not thought to be influenced by environmental differences. However, it was believed that the postneonatal deaths which take place between the ages of one month and one year would continue to exhibit an inverse relationship with socioeconomic status because the major causes of deaths at these ages (e.g., infectious diseases, accidents) are farther removed from the physiological processes of gestation and birth and are more directly related to environmental factors.

In explaining this apparent blunting of the relationship between total infant mortality and socioeconomic status, Willie and Stockwell suggested that it was due to improved public health measures and the effectiveness of improved medical techniques in fighting infectious causes of death

(Stockwell, 1962a:111), as well as to improved sanitary codes, housing regulations, and the occurrence of practically all births in hospitals (Willie, 1959:227). Moreover, it was anticipated that a continuation of these trends would likely promote a further blunting and perhaps even an elimination of this mortality differential. However, this does not seem to have occurred. On the contrary, an examination of the findings and conclusions of more recent studies show that considerable confusion exists today concerning the nature of the relationship between infant mortality and its component parts to socioeconomic status. On the one hand, in a longitudinal study of Chicago between 1930 and 1960 Kitagawa and Hauser (1973) found a considerable narrowing of the socioeconomic differential in infant mortality. On the other hand, data for New York City (Institute of Medicine, National Academy of Sciences, 1973) indicate that the traditional inverse relationship is still apparent. The findings of other research have indicated that the inverse relationship also applies to the neonatal component of infant mortality. This has been demonstrated for New York City (1961-1963) by father's occupation (Shapiro, Schlesinger, and Nesbitt, 1968). It may also be noted that this relationship is not unique to the United States but has also been observed in other industrialized low mortality countries (National Center for Health Statistics, 1966; 1968a; 1968b). Finally, in one other study of trends among states it was

noted that the state data comparing the infant mortality/socioeconomic status relationship remained unchanged from 1938 to 1968 for occupation and education, while for percent black, and contrary to expectations, the relationship increased (Brooks, 1975a).

It should be obvious from the preceding that the relationship between infant mortality and socioeconomic status is a topic requiring continued research. Further, because they are due to different causes and are therefore likely to require different remedial programs, the neonatal and post-neonatal components of infant mortality need to be examined separately in relation to the various socioeconomic variables to determine adequately the nature of this relationship. The aim of the present research, a longitudinal study of the relationship between infant mortality (total, neonatal and postneonatal) and selected measures of socioeconomic status in the city of Toledo, Ohio, is to present data to try and clarify some of the present confusion and to further enhance our knowledge and understanding of this relationship.

Data and Methods

The present reserach on the relationship between the components of infant mortality and various measures of socioeconomic status employs an ecological approach. The basic unit of analysis is the census tract of mother's usual residence. Live birth and infant death data were obtained from the Bureau of Vital Statistics, Toledo Department of Health and

the Ohio Department of Health. The summary socioeconomic characteristics of census tracts were obtained from the 1950, 1960 and 1970 Censuses of Population and Housing for the Toledo Standard Metropolitan Statistical Area (SMSA). The census tracts were utilized as the basis for ranking and grouping "socioeconomic areas" for a social area analysis of the three time periods under investigation. The relationship between census tract infant mortality rates and socioeconomic characteristics was also measured and analyzed by means of correlation analysis.

In all analyses, the independent variables consisted of several selected socioeconomic characteristics of the census tracts of the city of Toledo. The major variables examined were family income, education, occupational composition, housing and family characteristics. The dependent variables were the census tract infant mortality rates: total, neonatal, and postneonatal. Because of the difference between white and nonwhite infant mortality rates, race was the major control variable. Further discussion of these techniques and variables will be presented in Chapter III.

Purpose of the Study

The purpose of the present study was (1) to measure the relationship between infant mortality and socioeconomic status in Toledo, Ohio, by analyzing three different time periods (1949-51, 1959-61 and 1969-71), in order to ascertain the nature and extent of any changes and/or trends over time

in the traditional inverse relationship; (2) to compare these time periods separately to other studies of the same or similar time periods; (3) to compare the Toledo trend to that observed in other longitudinal studies; and (4) to make some suggestions for the consideration of future infant mortality research.

The major limitation of studies such as this, which employ an ecological approach, is that the socioeconomic characteristics do not refer specifically to the individual parents of an infant death. Instead the socioeconomic characteristics are averages based on the entire population of each tract. However, as other research has indicated, it is felt that the characteristics of the tract population are a reasonably good indicator of its overall socioeconomic status and as long as one is aware of the problem and limitations their use in such research can be justified (Shevky and Williams, 1949; Shevky and Bell, 1955; Stockwell and Nagi, 1968).

This research derives significance from the fact that a longitudinal analysis of a single city should reveal more clearly the nature of the trends in the infant mortality/socioeconomic status relationship. Even though only one city is involved, it is hoped that this research will contribute substantively to clarifying the current state of knowledge concerning this important mortality differential.

Plan of Presentation

In the following chapter we shall present an overview of some of the more important research on the relation between socioeconomic status and mortality, particularly infant mortality, in the United States. This review of the literature will first focus on mortality and socioeconomic status and will then focus on three distinct time periods for infant mortality and socioeconomic status: prior to 1950, 1950 to 1959, and 1960 to the present (dates will refer to the data years of the studies rather than date of publication). Longitudinal studies will be reviewed for these time periods according to the latest year of the data. The various methodologies of the studies will also be examined. Chapter III will be concerned with the methodological and statistical procedures of the present study as well as the data on which it is based. Chapter IV deals with the findings of the empirical investigation between infant mortality and socioeconomic status for both the social area analysis and the correlational analysis. A final chapter summarizes the results of the analyses, and presents some conclusions with respect to the nature and extent of the relationship between infant mortality and socioeconomic status as it currently stands.

CHAPTER II
RESEARCH ON SOCIOECONOMIC MORTALITY DIFFERENTIALS
IN THE UNITED STATES

It has been more than a decade since anyone has presented a review of the research findings on socioeconomic mortality differentials. At that time (during the 1960's) two reviews were published which seemed to suggest that there was some basis for optimism with regard to the future course of socioeconomic mortality differentials. In the first of these Stockwell (1961) reviewed the literature on socioeconomic mortality differentials in the United States indicating the type of research that has been done in this area and the nature of the results obtained. One kind of research focused on the relationship of mortality and other health characteristics to occupation. In spite of the limitations inherent in these studies (e.g., occupation engaged in at the time of a census enumeration and the kind of work engaged in during most of one's working life is not completely compatible with that recorded on the death certificate), Stockwell pointed out that most of them demonstrated a clear inverse relationship between mortality and occupational status. The same conclusion was suggested by his review of other studies using a variety of research approaches including various

sample surveys as well as the more common census tract analyses. At the same time, however, he noted that some confusion existed concerning this relationship and pointed to his own work (Stockwell, 1962a, 1963a) and Willie's (1959) study, as mentioned in Chapter I. Stockwell (1961) also noted that although most of the studies that had been carried out in the post-World War II era revealed the existence of a fairly pronounced inverse relationship between mortality rates and socioeconomic status, there seemed to be emerging differences as to the magnitude of the differential, and as to whether or not it was narrowing. Based on a review of several studies during the 1950 decade, as well as on the results of his own research (Stockwell, 1963a), it was concluded that both the extent of the socioeconomic differential and its trend depended on such things as the area under investigation, the particular variables used to measure socioeconomic status, and the nature of the methodological procedures followed. Further, the very fact that what had previously been a consistent and pronounced inverse association was now so variable led him to speculate about an emerging trend toward a closing of the socioeconomic status mortality gap.

In the second review Antonovsky (1967), analyzed thirty studies based on a multiplicity of methods and indices ranging from the 1680's to the early 1960's. The relationship between health, disease, mortality and social class was seen to be complex and to vary over time. Only three studies

showed an absence or near absence of class differentials. However, somewhat similar conclusions were reached as in Stockwell's earlier review. Although it was emphasized that a socioeconomic differential still existed, there was clearly a trend toward a blurring of the traditional pattern. Specifically, it was noted that the differentials then observed were pretty much limited to a difference between the lowest class and all others. That is, what had once been a fairly smooth inverse gradient across several socioeconomic class levels was now one in which similar low death rates characterized all the upper and middle class groupings, with a much higher death rate prevailing in the lowest group. This pattern of a blurring of the traditional inverse relationship was explained in terms of the continuation of the historical decline of mortality in our society. That is, it was suggested that when mortality levels are extremely high or extremely low (e.g., at the two extremes when men and women either have very little control over their life chances or when they have achieved a great deal of success in controlling mortality), social class differences will be small; and further that it is during the transitional phase from high to low death rates, when the fruits of health progress filter slowly down from the richer to the poorer classes, that the socioeconomic differential is most apparent. This being the case it would suggest the hypothesis that as the overall death rate of a population continued to decline the remaining class differences

would also diminish. Although the lowest socioeconomic groups were still characterized by a notable mortality disadvantage, the fact that the mortality levels of all other classes had blurred clearly suggested that this differential was not inevitable and that it could become even more blunted with further advances in the control of mortality.

The several studies Antonovsky (1967) referred to as having little or no class differentials, and Stockwell's (1962a, 1963a), Willie's (1959), and Willie's and Rothney's (1962) research clearly show an inconsistent trend not only in the mortality/socioeconomic relationship but in its magnitude as well.

The remainder of this chapter will present a more detailed review of the mortality/socioeconomic status relationship and the infant mortality/socioeconomic status relationship. The latter will be reviewed in time periods in order to depict more precisely the emergence of the apparent controversy of this relationship. In this review, data time periods will be used rather than publication time periods. The data years of the infant mortality/socioeconomic status relationship, it is felt, would yield a more definitive trend because the time the data were collected and not the date of publication will give the best view of the relationship over time (e.g., a paper published in the 1970's may be based on 1950 data, and will therefore not be an adequate representation of the most recent situation).

Research on Mortality and Socioeconomic Status

Studies of the relationship between socioeconomic status and mortality, including infant mortality, prior to 1950 are few. Most data on mortality are collected from the vital statistics registration system; and it was not until 1933 that all states and the District of Columbia were admitted to both birth and death registration areas. Ninety percent of all deaths and births occurring in a state had to be registered in order for it to be admitted, but ways of measuring were often very crude. Only ten states and the District of Columbia were in the Original Death Registration Area of 1900 (Shryock, et al., 1976:21). However, data for periods prior to 1950 has been increasingly analyzed recently by way of longitudinal designs.

From incomplete and scattered data, it can be concluded that mortality in the United States was high and fluctuating throughout the 18th and the first half of the 19th century. (Mortality was higher in urban than rural areas, higher in southern than in northern states, and was much higher among nonwhites and the poor than among the white and affluent populations.) To substantiate these assertions, data for the late 18th century for the Boston area, and the states of Massachusetts and New Hampshire indicate that death rates were 33 per 1,000 for the white population and 70 per 1,000 for the slave population. In 1798, expectation of life at birth was 35 years indicating that mortality has high. By

1900, the death rate declined to about 17-18 per 1,000 and life expectancy at birth had increased to 47-48 years (Omran, 1977).

Since 1900 mortality in the United States has declined at a fairly steady pace to the point that in 1970 the crude death rate was approximately 9 per 1,000. The white death rate, when standardized for differences in age composition, has always been lower than the nonwhite, and within each racial group females have experienced lower mortality than males. Life expectancy at birth in 1970 was 71.7 years for the white population and 65.3 years for the nonwhite population indicating considerable improvement from the turn of the century, but still demonstrating racial differences that are explainable in large measure by social and economic differences (Omran, 1977).

One of the earlier attempts to examine socioeconomic mortality differentials on a national level in the United States is the study by Marion Altenderfer (1947) who examined mortality and per capita income in 92 United States cities of 100,000 or more population. The mortality data were obtained from a report of the Bureau of the Census containing the number of deaths of residents of each city for the two year period 1939-1940. Altenderfer grouped the cities into three equal groups based on average per capita buying income. She found that mortality levels were inversely related to economic status, and that this association was independent of the age

composition of the population and was affected only slightly by variations in racial composition (pp. 1688-1689).

More recently Yeracaris (1955) examined mortality and socioeconomic status for 72 census tracts in Buffalo, New York for the years 1939-1941. In this study census tracts were grouped into five socioeconomic areas based on median rental value of residences. Again the findings indicated that there was an inverse relationship between socioeconomic status and mortality rates.

Patno (1960) conducted a longitudinal study of the relationship between mortality and economic level for 1940 and 1950 in Pittsburgh, Pennsylvania, grouping census tracts into low, middle, and high residential areas. Economic level was based on median monthly rent, median home value, and median family income. Patno found little evidence to indicate that an inverse relationship no longer existed between mortality and economic level, but did suggest a possible association of mortality with changes in the relative economic levels of residential areas (p. 840). In both 1940 and 1950 an inverse relationship between low and high groups were just as great in 1950 as in 1940 for the age groups 30 to 69. Also in both years, the frequency of deaths from certain causes appeared to be closely related to economic level. Patno concluded that in a large modern city, the well established inverse relationship between economic status and mortality was still striking.

Tuckman et al. (1965) found an inverse relationship between occupational level and mortality for deaths from all causes, as well as specific causes. Data were obtained from a national report of mortality by occupation and cause of death among men 20 to 64 years of age in the United States in 1950. This study found that although both hazards on the job and those related to lower social class membership contribute to mortality rates, there is a greater contribution of social class to mortality than job hazards. Evidence of this is provided by the fact that when married women were classified according to the occupation of their husbands, they exhibited the same mortality pattern (pp. 576-577).

In a study examining total mortality and socioeconomic status in Providence, Rhode Island, and Hartford, Connecticut, in 1950, Stockwell (1960a, 1963a) used two indexes to rank census tracts into social areas. They were the "SW index" which was a composite measure based on the occupation, education, and income composition of census tract populations and the "5C index," which added measures of rental value and overcrowding in dwelling units to the three components of the SW index. In both cities there was a pronounced inverse relationship between mortality levels and the overall socioeconomic status of the tract populations. Stockwell also demonstrated, however, that the precise conclusions one can draw will vary considerably with the methodological conditions characterizing a particular study. Further, he found that

the association was not the same for all components of socioeconomic status, nor did all aspects of mortality exhibit similar patterns of association with the same components of socioeconomic status. Thus he concluded that although most earlier studies had revealed the existence of a clear-cut and extremely marked inverse relationship between socioeconomic status and mortality, the results of his research were much less conclusive (pp. 962-963).

In still another study Quinney (1965) examined the relationship among census tracts in the Lexington, Kentucky, SMSA. For his analysis Quinney employed two composite social rank indexes as well as single variable indexes for 1960. The two indexes he used were the Shevky-Bell Social Rank Index which was based on education and occupation, and a T-score index, which was based on mean scores of housing value, education, occupation and family income. He found that the mortality/socioeconomic status relationship was markedly inverse for whites, but tended to be slightly positive for blacks for both the composite and single variables indexes. The only age group that lacked any discernible association with socioeconomic status was the 20-39 age group.

Using a similar ecological approach for Hartford, Connecticut, for 1960, Nagi and Stockwell (1973) found a pronounced inverse relationship between socioeconomic status and mortality from nine causes of death. The strongest association was for infectious and parasitic diseases, but

an inverse relationship was also apparent for chronic diseases. These findings are similar to Quinney's (1965) and conflict with the usual explanation of socioeconomic mortality differences being largely a function of the higher incidence of acute diseases among lower socioeconomic groups.

In the most definitive study to date, Kitagawa and Hauser (1973) investigated mortality and socioeconomic status using a variety of data sources: (1) the 1960 "matched records study," in which 340,000 deaths occurring during the period May through August 1960 were matched to the 1960 census records in order to obtain a variety of social and economic characteristics of decedents; (2) a series of Chicago studies analyzing socioeconomic differentials in a metropolis during a 30 year period from 1930 to 1960; and (3) 1959-1961 deaths for the entire nation compiled by the National Center for Health Statistics. A strong inverse relationship of mortality to level of education was obtained for both males and females, with consistent declines in mortality as years of education increased. This also occurred with income. Specific causes of death were also inversely related to education and income. On the basis of the individual data collected from the fairly detailed census death certificate matching study, Kitagawa and Hauser pointed to the existence of a clear socioeconomic mortality differential as measured by both education and income. Data were also presented showing that occupation was related to mortality level, although this relation was

a fairly erratic one and led the authors to conclude (p. 43) that occupation was the least desirable indicator of socioeconomic status to use in the study of differential mortality. In interpreting their findings, Kitagawa and Hauser pointed out what is known as the reverse causal path, that is, the approach of death itself is the cause of decreased income during the year preceding death; for this reason and because of the variation in income over the life cycle, it has been suggested that education is a better predictor of mortality because it remains fixed after young adulthood (pp. 7-8).

Kitagawa and Hauser concluded that (1973:178-180):

The relatively high mortality of the United States compared with other advanced nations is undoubtedly in large measure a reflection of the high mortality of the disadvantaged in the nation--the lower socioeconomic groups of whites and the even more disadvantaged minority groups. . . . Perhaps the next most important gain in mortality reduction is to be achieved through improved socioeconomic conditions rather than through increments to and application of biomedical knowledge.

In another study using 1960 data and census tracts as their basis unit in Columbus, Ohio, Schwirian and Lagreca (1971) suggested that mortality may be explained largely in terms of subarea differences in age structure, social status levels, and housing conditions. While the impact of housing and age were shown to be direct, the effect of status was shown to operate through the housing variable. The effects of housing and status upon mortality were accentuated in those areas where the population was comparatively young, and an inverse relationship was found between socioeconomic

status variables and mortality. The authors claimed that bad housing is a surrogate for other social and economic conditions and that urban mortality differences are produced by the interaction of demographic, environmental, and social influences (pp. 585-587).

The early 19th century mortality decline in the United States was not triggered by advances in medical and sanitary practices or health delivery. Improvements in living standards proved to be the major contributor to mortality reduction (Omran, 1977). Improvements in nutrition, with a greater variety of foods that also had more nutritional value, helped to increase the body's resistance to infection and therefore reduced the prevalence of diseases. Other living standard improvements included better personal hygiene, improved housing, and sanatorium treatment for tuberculosis which was a major cause of death in the 19th century. Ecologic recession of certain diseases while other diseases changed in virulence and/or occurrence over time contributed to mortality reductions. Only toward the end of the 19th century did health and sanitation measures contribute to the mortality decline (Omran, 1977). Among the more significant developments here would be water purification and the construction of improved urban sewerage systems.

Omran (1977:39) stated the conclusion that "social and economic factors have been influential in the mortality decline is further supported by the fact that the decline

has been smaller and much delayed for the nonwhite population in the U.S., with their lower standards of living." Many of the previously cited studies of mortality and socioeconomic status reveal this same conclusion, not only for the nonwhite population of the United States, but for the entire lower socioeconomic population. Although a variety of socioeconomic indexes were used (composite indexes; and a variety of single variable indexes--education, occupation, income, etc.), as well as numerous different units of analyses (e.g., census tracts, whole cities, occupational categories, individual data) in different areas of the United States, all of the studies revealed the existence of an inverse relationship between socioeconomic status for data years ranging from 1930 to 1970.

The most common approach to studying this topic has been an ecological one and has used census tracts as the basic unit of analysis. All of these studies point to the existence of a marked socioeconomic mortality differential, and the overriding conclusion that seems to be warranted is that contrary to the earlier optimistic speculations, there has been little if any change in the situation since the 1950's. Recent studies, in fact, have revealed that a strong socioeconomic mortality differential characterizes cities as diverse in size and characteristics and as widely separated in space as Lexington, Kentucky (Quinney, 1965), Columbus, Ohio (Schwirian and Lagreca, 1971), Chicago, Illinois (Kitagawa

and Hauser, 1973), Hartford, Connecticut (Nagi and Stockwell, 1973), and Phoenix and Tucson, Arizona (Stockwell et al., 1977) (see Table 1). Beyond noting that it still exists, however, one has to conclude that the precise nature of this differential is still inadequately understood. To illustrate, there is disagreement as to whether it characterizes all segments of the population. In the study of Lexington, for example (Quinney, 1965), in which three separate measures of socioeconomic status and a combined index were used, very little association was found between socioeconomic status and mortality for the young adult group (ages 20-39). This observation conflicts with both the findings of a number of earlier studies (Antonovsky, 1967) and with more recent data (see Table 2) which suggest that the socioeconomic differential is most pronounced among the early adult ages. Similarly, although the same Lexington study revealed a positive association between socioeconomic status and mortality for nonwhites, data for Chicago in 1960 and for both Phoenix and Tucson in 1970 (see Table 3) indicate that the inverse differential is just as pronounced for nonwhites as it is for whites.

The particular index of socioeconomic status used does not seem to effect the existence of the relationship, but there is some variation as to its magnitude, and such variation could be significant for the kind of conclusions drawn. Most of these city socioeconomic areas are based on median family income (Chicago, Lexington, Phoenix and

TABLE 1

AGE-STANDARDIZED AVERAGE ANNUAL DEATH RATES PER 1,000
POPULATION FOR FIVE SOCIAL RANK AREAS, WHITE POPULATION
BY SEX, FOR VARIOUS CITIES AND DATES

City and Year	Sex	Socioeconomic Area					Ratio
		I (High)	II	III	IV	V	V:I
Chicago, 1930	M	11.6	12.4	13.6	15.4	18.8	1.62
	F	6.6	7.2	8.4	9.9	13.2	2.00
Chicago, 1940	M	11.0	10.8	11.5	13.4	16.6	1.51
	F	5.8	5.6	6.3	7.8	10.4	1.79
Chicago, 1950	M	8.7	9.4	9.7	11.6	14.6	1.68
	F	4.2	4.9	5.1	6.4	8.6	2.05
Chicago, 1960	M	9.6	9.2	10.1	11.3	16.0	1.67
	F	4.7	4.5	5.2	6.0	8.6	1.83
Houston, 1950	M	7.5	7.9	9.1	11.1	9.9	1.32
	F	5.4	5.3	5.6	7.1	7.5	1.39
Providence, 1950	M	10.8	11.8	11.2	12.7	14.0	1.30
	F	7.3	7.6	8.9	9.4	10.4	1.42
Hartford, 1950	M	9.3	10.3	11.2	11.8	12.5	1.34
	F	6.6	7.5	7.5	8.2	8.3	1.26
Phoenix, 1970	M	9.8	10.9	11.5	13.4	18.2	1.86
	F	6.4	6.6	6.4	7.2	8.9	1.39
Tucson, 1970	M	8.8	9.9	9.5	11.5	15.1	1.72
	F	6.3	6.3	5.0	6.6	7.9	1.25

SOURCES: Chicago data (Kitagawa and Hauser, 1973:53); Hartford
Providence, and Houston (Antonovsky, 1967:54);
Phoenix and Tucson (Stockwell, Wicks, and Adamchak,
1977:14).

TABLE 2

AGE-SPECIFIC WHITE DEATH RATES, BY SEX, FOR HIGHEST AND
LOWEST SOCIAL RANK AREAS IN PHOENIX, 1970

Age	High SES	Low SES	Ratio Low:High	High SES	Low SES	Ratio Low:High
	<u>WHITE MALES</u>			<u>WHITE FEMALES</u>		
0-1	11.8	21.3	1.81	13.2	11.9	.90
1-9	0.8	1.2	1.50	0.3	1.3	4.33
10-19	0.8	1.3	1.63	0.4	0.7	1.75
20-29	2.7	4.0	1.48	0.7	1.2	1.71
30-39	1.6	7.6	4.75	0.8	3.8	4.75
40-49	3.2	16.3	5.09	2.6	5.9	2.27
50-59	9.6	30.7	3.20	5.3	11.6	2.19
60-69	36.6	56.9	1.55	13.1	21.4	1.63
70+	77.3	102.4	1.32	61.2	64.9	1.06

SOURCE: Stockwell, Wicks, and Adamchak, 1977:15.

TABLE 3

AGE-STANDARDIZED DEATH RATES OF NONWHITES, FOR HIGH AND LOW
SOCIAL RANK AREAS, FOR VARIOUS CITIES AND DATES

City and Year	High SES	Low SES	Ratio Low:High
Chicago, 1960	9.8	16.7	1.70
Male	9.8	16.7	1.70
Female	8.1	11.6	1.42
Phoenix, 1970	7.3	12.0	1.64
Tucson, 1970	5.7	9.6	1.68

SOURCE: Stockwell, Wicks, and Adamchak, 1977:16.

Tucson) and Quinney (1965) found the highest correlation between socioeconomic status and mortality to characterize the income variable. In Columbus, however, Schwirian and Lagreca (1971) found that housing conditions (percent of dwelling units in sound condition) were much more highly correlated with mortality rates than was median family income.

To cite one other illustration, the data presented in Table 1 would also suggest that the nature of the socioeconomic differential by sex is also unstable. Although, as would be expected, female death rates are everywhere lower than corresponding males rates, the relative difference between the lowest and highest economic areas is notably greater for females at every year in Chicago; but it is substantially more pronounced for males in both Phoenix and Tucson. Finally, with respect to the earlier postulated blurring of class lines above the lowest group, the data presented in Table 1 would suggest that this may be the trend for females, but that such a blurring has not characterized males to the same extent--particularly in the two Arizona cities.

What these isolated findings from a few selected studies indicate, then, is that we still pretty much are where we were at the start of the 1960 decade. We know without question that a low socioeconomic status is associated with a higher than average death rate, but when it comes to making more specific conclusions there is still a good deal

of variation from one area to another, from one population subgroup to another, and from one measure of socioeconomic status to another.

What is more important, however, is that we have not made much progress in explaining what it is about a low socioeconomic status that results in the higher death rates; and the unfortunate corollary is the already noted fact that we have not made any real progress in eliminating or reducing this differential. Beyond some noteworthy attempts to isolate the socioeconomic status component that contributes most to the differences in mortality (for example, the specification by Schwirian and Lagreca (1971:585-587) that the effect of status on mortality operates through the housing variable, and likely reflects such concomitants of poor housing conditions as inadequate lighting, heating and sanitation, as well as the higher incidence of certain social problems like alcoholism, broken homes and drug addiction), there has been a lot of speculating and hypothesizing, but very little real research, relating to the influence of such things as genetic inheritance (Quinney, 1965), and to differences in health care knowledge and access to good medical care, especially preventive care (Antonovsky, 1967:67). And the need for research with respect to these kinds of factors is especially important today as the influence of infectious diseases has declined and as the chronic diseases, particularly heart disease, have assumed a greater and greater responsibility

for the pronounced mortality disadvantage characterizing the lowest socioeconomic groups in our society (Quinney, 1965; Nagi and Stockwell, 1973).

Research on Infant Mortality and Socioeconomic Status

In the earlier part of this century, Woodbury (1926) conducted a study of infant mortality in eight United States cities. He compiled data for these cities for years ranging from 1911 to 1915, and found an overall infant mortality rate of 111.2 per 1,000 live births. The majority of infant deaths at this time occurred during the postneonatal period; the death rate for this latter period of infancy was 66.4 per 1,000 live births as compared to 44.8 for the neonatal period. Woodbury also examined and found differentials by sex, physical condition of mother, frequency of birth (parity), type of birth (premature, plural), type of feeding, race and nationality of mother, housing congestion, and economic factors. The economic factors included employment of mother during pregnancy, employment of mother during the first year of the infant's life, and earnings of father. Woodbury found that earnings of the father had a close association with infant mortality directly and indirectly through other economic and pregnancy related variables (e.g., mother's health and care during pregnancy and confinement, and care of the infant during the first year).

The infant mortality rate in the United States has declined greatly since Woodbury's pioneering study, and the

neonatal-postneonatal distribution pattern has been reversed so that today the vast majority of infant deaths occur during the neonatal period. The United States infant mortality rate in 1915 (the first year for which national statistics on both births and infant deaths were available) was 99.9 per 1,000 live births. By 1976 this rate was down to 15.1 per 1,000 live births, indicating a decrease of 85 percent. However, this seemingly huge decline did not equally benefit all groups of the American population. Many of the same differentials that Woodbury found still exist today. In particular, groups characterized by different social and economic conditions did not all share the same declines in infant mortality, and such differentials have been the basis for the continuing study of infant mortality and socioeconomic status throughout this century. In the remainder of this section we shall examine the major research on this topic in more detail.

Research Prior to 1950

As with total mortality, it is difficult to estimate the precise level of infant mortality in the United States during the 18th and 19th centuries. We can be fairly certain that it was well over 100 per 1,000 live births and could even have exceeded 200 in some years. At the beginning of the present century evidence suggests that one in ten infants died in the first year of life. By the mid 1930's, the infant

mortality rate was halved to approximately 50 per 1,000, and between 1935 and 1950 the infant mortality rate fell by approximately 4.7 percent annually (Bouvier and van der Tak, 1976). Table 4 shows the high infant mortality rates in the second half of the 19th century in Massachusetts, and the rapid decline that followed. The infant mortality rate steadily declined in the United States until the early 1950's and then leveled off, while other nations continued to record major decreases in their infant losses. This contributed to raising the problem of infant mortality as a major public health issue in the United States. This issue was felt more sharply by public health circles because they recognized that the level and trends in the infant mortality rate varied among different segments of the population, and those segments at the greatest risk showed the smallest reductions in infant mortality (Schlesinger, 1967).

Infant mortality/socioeconomic status research studies based on data prior to 1950 all revealed a fairly pronounced inverse relationship. This was not only the case in the United States, but in other developed nations as well. Morris and Heady (1955) found a strong inverse relationship between infant mortality and father's occupation in England and Wales from 1911 to 1950. They also found that there had been no narrowing of the social class gap in infant mortality. Douglas (1951) also found an inverse and significant social class differential in mortality during the first year of life

TABLE 4

INFANT MORTALITY RATE, MASSACHUSETTS, 1951-54 TO 1950-54

Period	Rate*
1851-54	131.1
1855-59	122.9
1860-64	142.5
1865-69	146.3
1870-74	170.3
1875-79	156.3
1880-84	161.3
1885-89	158.5
1890-94	163.2
1895-99	153.2
1900-04	141.2
1905-09	134.3
1910-14	116.7
1915-19	100.2
1920-24	78.7
1925-29	67.6
1930-34	53.9
1935-39	43.2
1940-44	34.3
1945-49	28.4
1950-54	22.8

SOURCE: U.S. Bureau of the Census, Historical Statistics, Series B 148, p. 57 (in Omran, Abdel R., 1977, Epidemiologic Transition in the U.S., Population Bulletin, Population Reference Bureau, Inc., 32 (2):20.

*Deaths to children under 1 year per 1,000 live births occurring in the same year or period.

in Great Britain for infants born in 1946, and between infant mortality and father's occupation in England and Wales for 1949 (Douglas, 1955).

Gover (1946) compared racial groups in the United States from 1920 to 1943. From 1920 to 1936 infant mortality declined at approximately the same rate for the black and white populations. Infant mortality continued to decline from 1936 to 1943 but at a more rapid rate for whites than blacks.

As noted earlier, Altenderfer (1947) examined infant mortality in relation to per capita income in 92 United States cities of 100,000 or more population. The data were obtained from the Bureau of the Census for the two year period 1939-1940. The cities were grouped into three equal groups, and infant and maternal mortality were both found to be inversely related to economic status.

In another study by Altenderfer (1949), infant mortality and four socioeconomic measures (racial composition, income level of the population, size of community, and utilization of medical facilities) were examined in 973 urban places of 10,000 or more population in 1939-1940. The urban places were grouped into quartiles based on their infant mortality rates. Per capita income, percentage of births hospitalized, and percent of white persons in the population were inversely related to infant mortality, but only a very slight association was found with size of city.

When infant mortality was correlated with each variable separately, controlling on the other three variables, an inverse relationship still existed, except for size of city. The latter association disappeared completely with standardization. Altenderfer concluded that hospitalization at delivery was a very important variable that lowered infant mortality; however, this variable also interacted with high income and a high percentage of whites in the population (pp. 336-337).

Yankauer (1949) examined fetal and infant mortality in relation to residential segregation in 318 neighborhood health areas of New York City for the three years 1945-1947. He found that as the proportion of nonwhite births in the grouped health areas increased, the fetal and infant mortality rates for both white and nonwhite populations also increased. He attributed this finding to the adverse social and economic conditions (especially inadequate housing) that nonwhites faced in New York City (pp. 646-648).

In another study in New York State, Yeracaris (1955) examined infant mortality and socioeconomic status for 72 census tracts in Buffalo for the years 1939-1941. Median rental value of residences was the basis for grouping census tracts into five socioeconomic areas. His findings indicated that there was an inverse relationship between socioeconomic status and infant mortality. The relationship was present for infants under one day and was more pronounced for deaths

at older ages. Specifically, the following differentials were observed in the Yeracaris study (1955:1242-1245):

- (1) The mortality rate of infants, both neonatal and postneonatal, is greater for females than for males.
- (2) There is an inverse relationship between infant mortality and economic status. Economic differences are present even during the first day after birth (for males) and become more pronounced as age at death of infants increases.
- (3) Economic differentials among males were more pronounced than among females in neonatal mortality.
- (4) The incidence of Negro infant deaths was greater than that of white infants.
- (5) The most frequent causes of mortality at an age less than one month were premature birth, injury at birth, and congenital malformations. Mortality from premature birth and from congenital malformations has not been reduced as drastically as that from other causes. It was mortality from these two causes which showed no significant relationship with economic group.
- (6) For infant mortality after the first month of life, premature birth, injury at birth and congenital malformations gave way to other causes such as respiratory diseases and diarrhea. General mortality from such diseases has been drastically reduced during the past 50 years. In this study, it was mortality from these causes that was inversely related to economic status.

The studies presented here, examining data collected prior to 1950, and specifically the 1940 decade in the United States, demonstrated a clearcut inverse relationship between infant mortality and socioeconomic status, with the lowest group having an infant mortality rate approximately 25 percent greater than the highest socioeconomic group. Nonwhites were at a clear disadvantage compared to whites prior to 1935, and the racial gap became even wider after

that date. The 1940 decade marks the beginning of extensive research on infant mortality and socioeconomic status, partly because the accessibility of data was enhanced as all states and the District of Columbia became part of the Vital Statistics Registration System by 1933.

Research From 1950 to 1960

Studies carried out during the 1950 decade yielded a diversity of findings that resulted in a growing confusion over the nature of the infant mortality/socioeconomic status relationship. Data during this period are still being compared in longitudinal designs in order to explain the apparent changes in this relationship during this period.

Although Illsley (1955) found an inverse and widening social class gap in prematurity rates and infant death rates in Aberdeen, Scotland for the years 1950 to 1954, data for the United States during the 1950 decade demonstrated a different pattern. Buetow (1961) found that infant mortality rose in Baltimore in 1957 with the neonatal component contributing to the overall rise. The increase in neonatal mortality was due to a significant rise in the death rate of black infants, and one of the factors considered in this rise was low socioeconomic status which characterized most of the black population in Baltimore in 1957. However, white neonatal mortality increased as well. Buetow (1961:227) concluded that the general rise in neonatal mortality was

due to the following factors:

- (1) A rise in the proportion of patients failing to seek prenatal care.
- (2) An increase in the incidence of puerperal morbidity.
- (3) A change in the age distribution of the neonatal deaths with an increase in the proportion of infants becoming ill and subsequently dying after the first 48 hours of life.

Willie (1959) examined infant mortality and socioeconomic status using a composite index of occupational, educational, and housing variables to group census tracts in Syracuse, New York for the 1950-1956 period. In general he found little association between infant mortality rates and socioeconomic status. Family income was significantly associated with both neonatal and postneonatal mortality but the composite index was significantly associated with only postneonatal mortality. Willie (1959:225-227) concluded that:

In all instances, however, family income or socioeconomic status factors accounted for less than 15 percent of the variance in the ecological distribution of neonatal or postneonatal mortality rates. The fact that sectors of high and low rates were found in all socio-economic areas and that variations in rates by socioeconomic areas were not statistically significant cast further doubt upon the hypothesis that socioeconomic status factors are primarily associated with the ecological distribution of neonatal or postneonatal mortality in Syracuse today as in years gone by. There was a patterning to the distribution of infant mortality rates. But socioeconomic status factors appeared to exert little effect upon it.

Using the same data as above, Willie and Rothney (1962) investigated variations in neonatal mortality by

racial and ethnic neighborhoods when socioeconomic status was held constant (using the same socioeconomic status indexes). They found that the association between infant mortality and economic circumstances of life was diminishing, and they concluded that black and native white populations have similar neonatal mortality rates when socioeconomic status was held constant. Neonatal mortality was inversely related to income where at least half of the households received less than \$2700 per year. No association existed between the distribution of neonatal mortality by neighborhoods and family financial status above the critical median income level of \$2700 per year (pp. 526-527).

In another study using census tracts as the basic analytical unit, Stockwell (1962a) found a complete absence of association between his composite socioeconomic index and infant mortality (his socioeconomic index was derived from measures of income, occupation, education, and housing characteristics of census tracts in Providence, Rhode Island in 1950). In fact, the highest social rank area had the highest infant mortality rate.

The postneonatal rate displayed an inverse relationship, however, but even this was not a perfect gradient. Each socioeconomic variable taken separately showed a significant negative relationship in the correlation analysis for total mortality, but for infant mortality, occupation, education, and median monthly rent displayed weak positive

associations. Only income was significant and inversely related to infant mortality. Stockwell's findings were also consistent with Willie's (1959) findings in Syracuse.

Both Stockwell's and Willie's research tended to point out not only the need for more research in this area, but particularly the need for some standardization of research procedures and a clearer specification of what was being measured (e.g., composite indexes of socioeconomic status as opposed to specific single indexes).

In an earlier longitudinal study of infant mortality by race, economic level, and cause of death for Detroit in 1940 and 1950, Mayer and Marks (1954) had reached conclusions similar to those of Willie (1959), Willie and Rothney (1962), and Stockwell (1962a). Grouping whites and nonwhites separately for three broad economic levels based on median rental values in census tracts, they observed an erratic pattern when cause of death was examined. Although infant mortality rates in the white population in Detroit for both 1940 and 1950 were inversely related to economic level, when looked at by cause of death the usual pattern did not apply in 1940 and caused the relationship to be somewhat inconsistent in 1950. This was due to the middle economic group having a higher rate of deaths due to prematurity than did either the highest or the lowest economic group. This was also true of the nonwhite population. A suggested cause of this is that the lowest economic group could have had a greater use

of social welfare facilities. Other findings were that the greatest reduction in infant mortality was attributable to environmental factors, and that the relative improvement among nonwhites was very slight as compared to whites during the decade 1940-1950 (pp. 149-155).

Examining fetal deaths and early neonatal deaths (within 24 hours after birth), Schlesinger et al. (1959) found no relationship of fetal mortality to socioeconomic status among six areas based on Willie's (1959) composite index. This study was conducted in Syracuse, New York and the county in which it is located (Onondaga County) in 1951-1952. When Schlesinger and his associates investigated early neonatal deaths and socioeconomic status, however, they did find an inverse relationship. As noted, neither Stockwell (1962a) nor Willie (1959) found an inverse relationship between neonatal mortality and socioeconomic status. They used similar data years and socioeconomic variables, and Willie's research was even in the same city as Schlesinger's study. The difference in findings could perhaps indicate the complexity of this relationship; that is, early neonatal mortality versus neonatal mortality (birth to 28 days). Even within this relatively short time period differences apparently existed in these rates in relation to socioeconomic status. Similarly, Rider et al. (1955) found in Baltimore in 1950-1951 that ". . . socioeconomic differentials among parturient women are important determinants of the magnitude of the incidence

of prematurity" (p. 1027). Donabedian et al. (1965), using a modification of the Shevky and Bell (1955) method, found a lack of relationship between hebdomadal mortality (first week of life) and socioeconomic status for the 90 census tracts of Boston for the five year period 1950-1954. All other segments of infant mortality (stillbirths, posthebdomadal, perinatal, postneonatal) decreased as socioeconomic status improved (p. 1093). Donabedian's finding with respect to the lack of a relationship between hebdomadal mortality and socioeconomic status differs from Rider's and Schlesinger's research. Donabedian claimed that the deferral of perinatal deaths (stillbirths plus neonatal deaths) among the high socioeconomic groups is the most likely explanation of this finding (p. 1093).

Based on the above findings as well as on his own research, Bogue was prompted to conclude that "in some advanced countries, rates for the first few days of life had shown little change, but rates for the rest of the first month were declining quite rapidly" (Bouvier and van der Tak, 1976: 14). Bogue (1969:588) also suspected that:

. . . the endogeneous factor dominates infant mortality only for the first three or possibly four days and that during the remainder of the first month, exogeneous factors are just as important as during the last 11 months.

Overall, the data on the relationship between infant mortality and its components and socioeconomic status for this period (1950-59) revealed considerable confusion

compared to the 1940 decade and earlier. The complexity of the relationship is not only revealed by the "type" of infant mortality under investigation (e.g., one to three or four days, first week, end of first week through first month, etc.), but by the methodological considerations as well. The measurement of socioeconomic status (e.g., composite indexes versus single variable indexes) could also be influencing this relationship.

Research Since 1960

The period since 1960 has produced far more research on the infant mortality/socioeconomic status relationship than any previous decade. Basically two kinds of studies can be distinguished that have examined the relationship between socioeconomic status and mortality: those which have collected data for individuals, and those which have been based on data for ecological units, particularly census tracts. By far most of the research on this topic has been of the second type. Due to the cost of individual studies and the lack of federal funding there have indeed been few studies of this type, and thus, most mortality/socioeconomic status studies have been of the ecological type. However, data based on individuals are badly needed to enhance our knowledge because such studies match socioeconomic and mortality characteristics of individuals and families, yielding a distinct relationship that is not subject to the weaknesses

in interpretation inherent in ecological research.

While such studies using individual data are useful (even necessary) for a full understanding of the nature and causes of the socioeconomic mortality differential, the fact that there have been so few of them (especially the lack of comparable studies over time) seriously limits the kind of conclusions that can be drawn from them (stockwell et al., 1977).

The variety of units and research techniques used and the vast amount of research during the 1960 decade and into the 1970's was sparked, we believe, by the confusion over the mortality and infant mortality/socioeconomic status relationship generated by studies based on data from the 1950 decade.

Bedger et al. (1966) examined socioeconomic characteristics in relation to maternal and child health in Chicago and Cook County, Illinois for the four year period 1960-1963. An ecological (census tract) approach using the Shevky-Bell (1955) method of social rank was employed. For Chicago, infant mortality rates increased as income decreased for the decile rankings. This inverse relationship was not clear for child and maternal mortality, although it was evident for the illegitimacy and prematurity rates. As in Willie's and Rothney's (1962) study, Bedger and her associates found that after a certain necessary minimum income, additional income has little effect on health factors. The most

significant change on rates on all variables occurred below the \$6000 income level. For suburban Cook County, infant mortality fluctuated widely, and a definitive inverse relationship between income and infant mortality was found only in the four lowest units in decile 10. Antonovsky (1967) found this situation with respect to total mortality--that the difference in social class was now between the lowest group and all other groups. Bedger concluded that inconsistent conclusions could be reached because deaths may be occurring among persons in upper socioeconomic levels in the lower socioeconomic areas, and further research should focus on individuals instead of ecological analyses.

Data derived from matched birth and death certificates of single live born infants in Baltimore for the period 1960 through 1964 were analyzed by Shah and Abbey (1971). In this study birthweight was found to be the most important factor in both neonatal and postneonatal mortality, and adjustments for other factors did not modify the effect of birthweight. Shah and Abbey (1971:54) concluded that:

Prenatal care appeared to be an important factor in both neonatal and postneonatal mortality. Race, socioeconomic status and maternal age were important in the neonatal period only because of their relation to birthweight. In the absence of birthweight effects, these factors were found to have no effect on neonatal mortality. . . . In the postneonatal period, however, all of these factors (except for race) were important. Next to birthweight, maternal age and live birth order were the most important factors in postneonatal mortality.

However, there is evidence that socioeconomic status

accounts (at least in part) for birthweight in a number of ways: (1) higher income may lead to increased ability to purchase medical care, (2) greater education may lead to greater awareness of when and where to seek medical care, and (3) socioeconomic status can be related to the prevalence of nutritional deficiency in the family, not only in the infant, but in the infant's mother while she is pregnant (Struening et al., 1973; Chabot et al., 1975, Adamchak and Stockwell, 1978). Therefore, the higher the socioeconomic status, the better medical and nutritional characteristics of pregnant women, and this could very well influence a lower incidence of low birthweight babies.

The longitudinal part of the Kitagawa and Hauser (1973) study of infant mortality in the Chicago area showed a marked narrowing of the socioeconomic differential between 1930 and 1960 (pp. 66-67). However, other data for New York City (National Academy of Science, 1973), the state of Ohio (Stockwell and Laidlaw, 1977), Toledo, Ohio (Adamchak et al., 1976; Adamchak and Stockwell, 1978), and for the nation as a whole (MacMahon et al., 1972; Kitagawa and Hauser, 1973), suggest that the traditional relationship is just as pronounced as ever. Kitagawa and Hauser found infant mortality to be inversely related to family income and to the educational level of parents. For example, mothers with only an elementary school education had an infant mortality rate that was 77 percent higher than mothers who had graduated

from college.

Hunt (1964) also examined census tracts of cities and found that in seven of the ten cities studied, neonatal and total infant death rates in 1961 were higher than in 1950. Hunt (1964:13-14) concluded that:

As evidenced by attainment of relatively low infant death rates in urban fringe areas and in high-income and otherwise favored neighborhoods of many cities, a major reduction in the infant death toll is technically possible through the application of already existing health and medical knowledge. Nevertheless, because of the association of high infant mortality with low family income, poor housing, little schooling, and other attributes of families in poor socioeconomic circumstances, significant reductions in infant mortality in these families and for the country as a whole depend upon continuing and combined efforts of many professional and auxiliary groups in the fields of community health, welfare, housing, education, and other services, as well as upon a major increase in the income level of these families.

Hunt (1967) grouped status into high, middle and low based on per capita income for 1963-1965. The units of analysis were states, counties, and poverty areas in large cities. Infant, neonatal and postneonatal mortality were all inversely related to socioeconomic status, but the differences were small between the high and middle group. The major difference was between the lowest group and the other groups, as Bedger et al. (1966), and Antonovsky (1967) had found.

Similarly, Jiobu (1972) found that increases or improvements in health care, housing and other services decreased socioeconomic differentials for 61 urban places in 1960. This association was found for postneonatal mortality which was apparently affected by socioeconomic factors despite

studies that indicate otherwise, and Jiobu cited Willie (1959) as one of these case studies. Jiobu's findings tentatively suggest that black-white differentials in neonatal mortality are generally unrelated to socioeconomic measures at an intercity level of comparison, because hospital birth differentiation was positively associated with neonatal differentiation (e.g., the greater the number of hospital births the greater the number of neonatal deaths). He concluded that although hospital birth differentiation has an impact, it is difficult to envisage hospital births as directly causing higher black neonatal rates (pp. 613-614).

In a study utilizing 49 states and the District of Columbia, Brooks (1975a) found that zero-order correlations between socioeconomic status variables and state infant mortality rates did not decline substantially between 1938 and 1968. Using path analysis, he found that the direct effects of percent black on state neonatal and postneonatal mortality rates have increased significantly (positive relationship) contrary to expectation, while the direct effects of percent white collar workers and median years of education remained virtually unchanged (negative relationship).

In another study by Brooks (1975b) using county infant mortality rates in the United States between 1961-1965, it was found that two variables had significant effects on infant loss; percentage of blacks and percentage of persons who have completed fewer than five years of school. These

two factors are also responsible in large measure for gross associations between low family income, sound housing, and rates of infant loss. Percent black and percent with low education were also found to correlate with and have appreciable direct effects on county neonatal mortality rates, which is contrary to the findings of Jiobu (1972) and Stockwell (1962a), and challenges the latter's suggestion that socioeconomic conditions are not as responsible for causes of neonatal deaths as they are for postneonatal deaths.

Other studies also point to an inverse infant mortality/socioeconomic status relationship. Shapiro et al. (1968) found an inverse relationship between father's occupation and infant mortality and its components, as well as with fetal and perinatal mortality for New York State (exclusive of New York City) for 1950-1952. For New York City in 1961-1963, Shapiro and his associates found an inverse relationship between father's occupation and neonatal mortality for both the white and black population (pp. 64-67). Hunt and Huyck (1966) also found that infant mortality was inversely related to socioeconomic status in 1960. This same relationship was found in 1964 for states, for New York City, Baltimore, Chicago, and Oakland. Hunt and Huyck concluded that "high infant mortality risks are associated with inadequate family resources" (p. 38). Their conclusion on racial differentials in infant mortality were that:

. . . the white-nonwhite differential in neonatal mortality, while widening, has not widened nearly so much as in postneonatal mortality as a larger proportion of nonwhite babies than white babies are taken home to hazardous environmental situations. . . . gains made and record rates achieved in the white group have subsequently been accomplished--but some two decades later--for nonwhite infants. The immediate issue is how to resume the downward trend of rates, which are currently rising or stationary, notably for nonwhite infants, but also for white infants, in low income families. (pp. 38-39)

MacMahon (1972) found a similar situation as Willie (1959), Stockwell (1962a), Bedger et al. (1966), Antonovsky (1967), and Hunt (1967)--that the major infant mortality/socioeconomic status differences were between the lowest group and all other groups, or that the inverse relationship was blurred. There was no important variation in infant mortality in relation to socioeconomic status between the median and higher groups. MacMahon's data sources were the National Center for Health Statistics and the National Office of Vital Statistics for the three year period 1964-1966. The relations with education of father, education of mother, and family income were of approximately equal strength; and the differentials between rates for whites and those for blacks and Indians were greater after the first month of life than in the neonatal period. Other findings by MacMahon were that exogeneous causes of death are particularly pronounced in the lower socioeconomic groups; differences in infant mortality rates between geographic regions in the United States are minor for whites, but nonwhite differences

are noticeable, especially in the first month; and the association between socioeconomic status and infant mortality was stronger in the South than any other region. MacMahon (1972:209) concluded that:

Approximately 25 percent of infant deaths are in excess of the number expected if all infants experienced the rates observed in the most favored socioeconomic classes. Rates in the lowest socioeconomic class, comprising about one-sixth of all births, are approximately double the rates in the highest socioeconomic groups. An implication is that one-half of the deaths of infants in the lowest socioeconomic group are preventable.

Bendor et al. (1971) found an inverse relationship between postneonatal mortality and father's occupation. A matching procedure was utilized in the eight counties of the San Joaquin Valley of California for 1964-1965. The mortality level of the lowest occupational category was nearly three times higher than that of the highest: 9.0 postneonatal deaths per 1,000 live births for farm laborers, and 3.3 per 1,000 for professional workers. The most striking finding was between prenatal care and occupation of father; higher socioeconomic status apparently does not reduce the risk of infant loss when the mother has had no prenatal care as it had done for all other factors (p. 485).

Other more recent research reinforces the conclusion that the traditional inverse relationship is still pronounced. Using families with income below the poverty level as the basis for ranking Ohio counties, Stockwell and Laidlaw (1977) found an inverse infant mortality/socioeconomic status

relationship for 1969-71-- for total infant mortality, and for both neonatal and postneonatal components.

A strong inverse relationship was also found in a pilot study for the present research (Adamchak et al., 1976). This study revealed the existence of a very pronounced inverse relationship between infant mortality and economic status among census tracts of Toledo, Ohio, with the lowest economic group having an infant mortality rate nearly three times greater than the highest economic group in 1970 (see Table 5).

Markides and Barnes (1977) also found a strong inverse relationship between infant mortality and socioeconomic status using a modified version of the Shevky-Bell (1955) index for the 115 tracts of San Antonio, Texas, for the five year period 1970-1974. This study is of particular interest because it points up a weakness in both Willie's (1959) and Stockwell's (1962a) conclusion that socioeconomic status is not sensitive to infant mortality rates since most infant deaths now occur in the neonatal period where socioeconomic measures are supposedly less attributable. Markides and Barnes claim that Willie's and Stockwell's analyses and the findings of two decades ago yielded weak associations because their studies were based on relatively small cities. The number of live births and infant deaths in each socioeconomic area, and in each tract, were too small to permit calculation of reliable infant death rates (Markides and Barnes, 1977:42). Although Markides and Barnes found a strong inverse relationship when

TABLE 5

INFANT MORTALITY IN ECONOMIC AREAS OF TOLEDO, OHIO: 1970

Percent of families with income below poverty level*	Deaths under 1 year per 1,000 live births
Less than 5% (11)	11.8
5% - 9% (15)	18.8
10% - 14% (13)	20.9
15% or more (13)	33.4

SOURCE: Adamchak, D. J., R. E. Siegel, E. G. Stockwell,
"Infant Mortality and Socioeconomic Status,"
Ohio's Health, 1976, 28(7):9.

*Number of parentheses are the number of census tracts in
each economic area.

using four socioeconomic groups with a composite index based on income, education, and occupation, when infant mortality was associated with each variable separately the relationship for total infant mortality was consistent with other findings in this section; namely that the major difference was between the lowest group and all the other groups, or that the relationship was in fact blurred. To illustrate, the difference between the first and third highest groups for income was 3.3 infant deaths per 1,000 live births or 22.9 percent between the third and fourth group (lowest group) (see Table 6). The difference for occupation was even greater. In fact, the second group was higher than the first and third which yields some inconsistency in the gradient. When single variables were grouped according to neonatal and postneonatal mortality, the inconsistency of the gradient increased, especially for occupation (see Table 6). Markides and Barnes neglected to explain these relationships. They critically examined social area analysis as a methodology and found results opposite from Willie's and Stockwell's findings for their composite index, but the differences were not as great for their single variable indexes. Their criticism seems justified but would have been better substantiated if they carried out their study longitudinally in order to compare San Antonio directly to the same or similar data years as Willie's and Stockwell's research. Because of the differences when single measures rather than a composite index is used,

TABLE 6

INFANT MORTALITY IN FOUR GROUPS OF CENSUS TRACTS RANKED BY
 MEDIAN FAMILY INCOME AND OCCUPATIONAL STRUCTURE:
 SAN ANTONIO, 1970-74

Income and occupational group	Infant Death Rates by Income			Infant Death Rates by Occupation		
	Total	Neonat.	Postnat.	Total	Neonat.	Postnat.
High	14.6	11.9	2.7	15.9	13.3	2.7
Med-High	15.9	12.2	3.7	16.3	12.4	3.9
Med-Low	17.9	13.2	4.6	16.0	12.8	3.1
Low	23.2	16.9	6.3	20.9	14.8	6.1
Total	18.3	13.7	4.6	18.3	13.7	4.6

SOURCE: Markides, K. S., and D. Barnes, "A Methodological Note on the Relationship Between Infant Mortality and Socioeconomic Status with Evidence from San Antonio, Texas," Social Biology, 1977, 24(1):41-42.

Markides and Barnes also suggest that infant mortality differentials be studied using a multivariate rather than a social area analysis approach.

To review this period as a whole and comparing it to the 1950 decade, it appears that from the mid-1950's to the mid-1960's the infant mortality rate changed very little. Since 1964, however, another downward trend has been in evidence, and from 1964 to 1974 the annual rate of decline in infant mortality averaged 4 percent. During the preceding decade of relatively unchanging infant mortality rates in the United States, infant mortality rates were dropping markedly in most other industrialized nations. It is not clear what forces were responsible for the decline in these other industrialized countries. There may have been contributions from advances in obstetrics, more widespread access to adequate prenatal care, improved nutritional status of women of childbearing age, changes in the number and spacing of children connected with more widespread availability of effective contraception and abortion, and contributions from unidentified factors. Whatever the causes, for approximately ten years ending in 1974, and continuing to the present, the United States has been experiencing reductions in infant mortality rates more nearly in line with the trends in other developed countries. However, as of 1973 there were 14 countries in the world that had lower infant mortality rates than in the United States (DHEW, 1975).

Historically, the infant mortality rate for minorities has been two-thirds higher as the rate for whites as shown in Figure 1. The infant mortality rate in 1974 for white infants was 14.8, but for nonwhite infants it was 24.9 per 1,000 live births. For the past decade infant mortality has been declining more rapidly for nonwhites than for white infants. The narrowing gap between white and nonwhite infant mortality follows a period of more than fifteen years in which the gap had been widening. The recent decrease has brought the white-nonwhite ratio back down to about the same level it was in 1950 (see Table 7).

Nevertheless, excess infant mortality in the minority segment of the population is still marked, and it is clearly related to the higher prevalence of poverty among minority groups. Data from the mid-1960's showing total, white, and black infant mortality rates by sex for three socioeconomic measures (see Table 8) indicates that the poorer segments suffered appreciably higher infant mortality rates than did the higher economic groups. However, the total and white infant mortality rates do not form a perfect inverse gradient when related to economic status. The median socioeconomic level has a lower infant mortality rate than most of the high socioeconomic levels.

This latest time period of data collection (1960-1978) revealed more consistency than the previous decade (the 1950's). Studies in the 1940 decade and earlier revealed

FIGURE 1

INFANT MORTALITY RATES BY COLOR: UNITED STATES, 1925-74*

Source: National Center for Health Statistics, Vital Statistics Rates in the United States, 1940-60. PHS Publ No. 1477; and Monthly Vital Statistics Report, Provisional Statistics, Annual Summary for the United States, 1974. Vol. 23, Number 13.

*Rates are the number of deaths under 1 year of age per 1,000 live births.

TABLE 7

INFANT MORTALITY RATES BY AGE AND COLOR: UNITED STATES,
1950 AND 1960-73*

Year	Total			Total			Total		
	under 1 year	under 28 days	28 days to 11 months	under 1 year	under 28 days	28 days to 11 months	under 1 year	under 28 days	28 days to 11 months
1973	17.7	13.0	4.7	15.8	11.8	4.0	26.2	17.9	8.3
1972	18.5	13.6	4.9	16.4	12.4	4.0	27.7	19.2	8.5
1971	19.1	14.2	4.9	17.1	13.0	4.0	28.5	19.6	8.9
1970	20.0	15.1	4.9	17.8	13.8	4.0	30.9	21.4	9.5
1969	20.9	15.6	5.3	18.4	14.2	4.2	32.9	22.5	10.4
1968	21.8	16.1	5.7	19.2	14.7	4.5	34.5	23.0	11.6
1967	22.4	16.5	5.9	19.7	15.0	4.7	35.9	23.8	12.1
1966	23.7	17.2	6.5	20.6	15.6	5.0	38.8	24.8	13.9
1965	24.7	17.7	7.0	21.5	16.1	5.4	40.3	25.4	14.9
1964	24.8	17.9	6.9	21.6	16.2	5.4	41.1	26.5	14.6
1963	25.2	18.2	7.0	22.2	16.7	5.5	41.5	26.1	15.4
1962	25.3	18.3	7.0	22.3	16.9	5.5	41.4	26.1	15.3
1961	25.3	18.4	6.9	22.4	16.9	5.5	40.7	26.2	14.5
1960	26.0	18.7	7.3	22.9	17.2	5.7	43.2	26.9	16.4
1950	29.2	20.5	8.7	26.8	19.4	7.4	44.5	27.5	16.9

SOURCE: National Center for Health Statistics: Vital Statistics of the United States, 1973. Vol. II, Mortality, Part A.

*Rates are deaths under 1 year per 1,000 live births.

TABLE 8

ESTIMATED AVERAGE ANNUAL NUMBER OF INFANT DEATHS PER 1,000
LEGITIMATE LIVE BIRTHS, BY RACE, SEX, FAMILY INCOME, AND
PARENTAL EDUCATION: UNITED STATES, 1964-66*

Family income and parental education	<u>Total</u>		<u>Total</u>		<u>Total</u>	
	Male	Female	Male	Female	Male	Female
Total	25.6	20.3	23.1	13.2	43.5	35.1
<u>Family income</u>						
Under \$3,000	36.2	27.9	32.0	22.4	44.3	40.7
\$3,000-\$4,999	28.1	21.9	24.7	19.2	53.7	38.9
\$5,000-\$6,000	20.3	15.9	19.5	16.1	29.8	15.1
\$7,000-\$9,999	21.3	18.2	20.8	17.4	-	-
\$10,000 and over	22.1	17.6	21.4	17.4	-	-
<u>Father's education</u>						
8 years or less	36.3	29.7	33.8	26.8	44.7	39.9
9.11 years	29.6	25.1	24.8	22.8	55.3	35.3
12 years	21.6	16.2	20.1	14.8	34.9	28.9
13.15 years	23.4	17.8	22.1	15.8	-	-
16 years or more	20.2	14.5	19.7	14.2	-	-
<u>Mother's education</u>						
8 years or less	37.6	32.9	34.8	29.2	48.0	44.0
9.11 years	31.0	24.2	27.2	21.8	47.2	35.6
12 years	22.6	16.1	20.8	14.9	41.1	27.2
13.15 years	14.9	16.9	14.6	15.3	-	-
16 years or more	24.0	16.0	23.2	16.0	-	-

SOURCE: National Center for Health Statistics: Infant Mortality Rates: Socioeconomic Factors, United States. Vital and Health Statistics, Series 22, No. 14, DHEW Pub. No. (HSM) 72-1045.

*Rates are deaths under 1 year per 1,000 live births.

a fairly consistent inverse infant mortality/socioeconomic status relationship; the 1950 decade demonstrated an inconsistent and confusing relationship; and the 1960-1978 period seemed again to indicate the existence of a fairly consistent pattern --an inverse relationship that emphasized small differences between middle and upper socioeconomic groups and large differences between the lowest group and all other groups, despite the different methodologies and indexes employed.

Summary, Discussion, and Hypotheses

The preceding review of research on infant mortality suggests the following conclusions:

(1) Data prior to 1950 indicated that there was a strong inverse relationship between infant mortality and socioeconomic status.

(2) Data for the 1950 decade indicated that the infant mortality/socioeconomic status relationship was becoming erratic and more variable compared to the previous period.

(3) Data for the 1960-1978 period suggests that an inverse relationship once again characterizes infant mortality and socioeconomic status. However, the pattern now appears to be one where the lowest socioeconomic group is sharply differentiated from the other socioeconomic groups, and where there are only minimal differences among middle and upper socioeconomic groups, even though the gradient still tends to be inverse.

The studies cited displayed a cross-section of units, time periods, methodological procedures, and regions of the country. The appropriate way to proceed, we believe, would be to separate those studies that differ from the traditional inverse relationship, and then compare them to the studies that resulted in an inverse infant mortality/socioeconomic status relationship.

Mayer and Marks (1954), Willie (1959), Willie and Rothney (1962), Stockwell (1962a), Donabedian et al. (1965), Bedger et al. (1966), and MacMahon (1972) all found an erratic or blurring infant mortality/socioeconomic status relationship. All but MacMahon used cities as their study site, primarily in the Northeast, and an ecological approach. The data years for these studies ranged from 1950 through the mid-1960's. In contrast to infant mortality, all studies concerned with total mortality for all periods revealed a fairly consistent inverse relationship. It appears, therefore, that infant mortality reacts differently than total mortality when associated with socioeconomic status.

As noted by Kitagawa and Hauser (1973), the secular decline in mortality in the United States came to a halt in the early 1950's and remained on a plateau until 1963. The Department of Health, Education and Welfare (1975) also noted that infant mortality remained basically unchanged (fluctuating and declining only slightly) from the mid-1950's to the mid-1960's, thus substantiating our literature review findings

that the studies cited employing data from the 1950 decade and early 1960's revealed an erratic or blurring infant mortality/socioeconomic status relationship. This changing or halting of the secular decline occurred for the crude death rate, and age-specific rates for both the white and nonwhite populations (Kitagawa and Hauser, 1973:3). Reasons for the plateau include a slowing down of the drop in mortality from infectious and parasitic diseases and an increase in mortality from degenerative diseases (Bourgeois-Pachat, in Kitagawa and Hauser, 1973:4). Could degenerative diseases have affected infant mortality in terms of affecting pregnant women? Could Willie's and Stockwell's composite indexes obscured the actual socioeconomic status of census tract groupings? Could the Markides-Barnes (1977) criticism of Willie and Stockwell be the most accurate explanation--that the cities they studied were too small with few infant deaths, thus yielding unreliable infant mortality rates? These are questions for which there are not now any satisfactory answers.

It appears from this review that different methodological unit approaches (ecological versus individual) could only be confusing the mortality/socioeconomic status relationship minimally. What seems to be affecting this relationship is the type of index (composite indexes could confuse actual socioeconomic status rankings), infant mortality versus total mortality, and the time period, as infant mortality/socioeconomic status studies of the 1950's displayed an

erratic relationship (Willie, 1959; Willie and Rothney, 1962; Stockwell, 1962a), and current studies show a pronounced inverse relationship (Brooks, 1975a; 1975b; Adamchak et al., 1976; Stockwell and Laidlaw, 1977; Markides and Barnes, 1977; Adamchak and Stockwell, 1978).

Finally, based on our review of the literature, we emphasize the need for: (1) longitudinal studies to determine the nature and extent of the infant mortality/socioeconomic status relationship in particular areas; (2) continued research on socioeconomic status and total mortality and socioeconomic status and infant mortality, since each type of mortality appears to be reacting differently with socioeconomic status; (3) single variable indexes and composite indexes used on a comparison basis; (4) multivariate and social area ranking techniques used on a comparison basis; (5) studies examining different regions of the country, and for different racial groups; and (6) an extensive examination of neonatal mortality as a special case because it constitutes approximately 75-80 percent of total infant mortality in the United States, and because there is now evidence that socioeconomic status accounts for this rate as well (Brooks, 1975b). This final point was emphasized by the Committee on Maternal and Child Care (1965:312-313).

Whereas socioeconomic comparisons in the United States are complicated by ethnic factors and inadequate data, evidence does indicate that perinatal deaths, birth weight, and prematurity rates vary with socioeconomic circumstances. However, it should be pointed out that

the range within a socioeconomic group and between geographical regions is as great as the range between groups in the population, making interpretation complicated. More detailed epidemiological research is needed for the socioeconomic effects to be fully comprehended.

Based on the literature review and the preceding generalizations, the following hypotheses will be utilized to guide the analysis of the relationship between infant mortality and its components and socioeconomic status in Toledo, Ohio for the years centering around 1950, 1960, and 1970.

H₁: The total infant mortality/socioeconomic status relationship will become increasingly inversely related from 1950 to 1960, and from 1960 to 1970.

H₂: Because of the growing body of evidence that neonatal mortality varies with socioeconomic factors, it is hypothesized that neonatal mortality will become increasingly inversely related with socioeconomic status from 1950 to 1960, and from 1960 to 1970.

H₃: Because postneonatal mortality has always been sensitive to socioeconomic factors, it is hypothesized that postneonatal mortality will become increasingly inversely related with socioeconomic status from 1950 to 1960, and from 1960 to 1970.

H₄: In the social area ranking analysis, the ratio of the lowest to the highest socioeconomic group will be greater in 1960 than in 1950, and greater in 1970 than in 1960.

H₅: In the social area ranking analysis, it is hypothesized

that the relationship between the lowest socioeconomic area and all other areas will become more distinct; that is, the relationship between the lowest area and all other areas will be greater in 1960 than in 1950, and still greater in 1970 than in 1960.

H_6 : In the correlation analysis, it is hypothesized that socioeconomic variables will explain more variance in infant mortality, neonatal mortality, and postneonatal mortality in 1960 than in 1950, and more variance in 1970 than in 1960.

CHAPTER III

RESEARCH METHODOLOGY

The present chapter describes the research procedures utilized to examine the relationship between infant mortality and socioeconomic status. The data collected for this project were obtained from local and state vital statistics offices, and from official publications of the U.S. Bureau of the Census. The basic approach is an ecological one that uses the census tracts of Toledo, Ohio as the analytical units. Socioeconomic differentials in infant mortality are examined using both a traditional social area approach based on relatively homogeneous groups of tracts, and by a multivariate analysis using single tracts.

The Study City

The purpose of the present research was to analyze the relationship between infant mortality and socioeconomic status. Specifically, infant mortality and socioeconomic status was analyzed to see how this relationship varied within a given city for single time periods, and between three different time periods, when different indices of socioeconomic status were employed and different methodological procedures were used. To fulfill this purpose, three time periods, each a decade apart in a single city were used to measure this

relationship in order to depict changes and/or trends. After careful consideration, Toledo, Ohio was chosen to fulfill the purpose of the study site (see Figure 2). Toledo was easily accessible to the author, and a preliminary inquiry assured the author of gaining access to the data needed.

Table 9 shows selected demographic and socioeconomic characteristics of Toledo for the three time periods covered in the study. The population increased 21 percent from 1950 to 1970 indicating a steady growth pattern. More significantly, as far as affecting infant mortality differentials is concerned, the nonwhite population increased nearly 40 percent. The economy of Toledo also expanded during this 20 year period. As the population increased, the percent of the labor force employed in white collar occupations decreased signifying a change in the basic economic structure of the city.

Comparing Toledo with Ohio and the United States on several selected socioeconomic characteristics in 1970 indicates that Toledo is slightly lower on median income and percent high school graduates (see Table 10). Occupational characteristics indicate that Toledo is an industrial/manufacturing city with one-third of its employed labor force engaged in manufacturing compared to 35.6 and 19.8 percent for Ohio and the United States, respectively. Toledo also had a lower unemployment rate in 1970 than the United States (4.3 versus 4.9), however, Ohio's rate was lower than both (3.8 percent). Toledo's percent employed in professional

FIGURE 2

MAP OF OHIO SHOWING THE CITY OF TOLEDO

TABLE 9

SELECTED DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF
TOLEDO, OHIO: 1950, 1960 and 1970

	1950	1960	1970
Demographic Characteristics			
Population	303,616	318,003	383,818
Sex ratio	96.3	93.2	91.7
Persons per household	3.2	3.1	3.0
Percent nonwhite	8.3	12.7	13.8
Socioeconomic Characteristics			
Median income of families and unrelated individuals	\$3,550	\$5,007	\$8,863
Median number of school years completed by persons age 25 and over	9.9	10.4	12.0
Percent white collar occupa- tions (professional, tech- nical, managers, administra- tors, sales, clerical, and kindred workers)	40.1	39.0	37.4
Percent of occupied housing units with 1.01 or more persons per room	6.6	6.4	5.3
Median monthly rent	\$37.78	\$61.00	\$79.00
Percent of labor force that is unemployed	6.4	7.2	4.3

SOURCES: United States, Bureau of the Census, Census of
Population and Housing, 1950, 1960, and 1970.
Toledo Standard Metropolitan Statistical Area.

TABLE 10

SELECTED SOCIOECONOMIC CHARACTERISTICS OF TOLEDO, OHIO, THE
STATE OF OHIO AND THE UNITED STATES: 1970

<u>Socioeconomic Characteristics</u>	<u>Toledo</u>	<u>Ohio</u>	<u>United States</u>
Median income of families and unrelated individuals	\$8,864	\$10,409	\$9,586
Percent high school graduates	49.8	53.2	52.3
Percent of labor force that is unemployed	4.3	3.8	4.9
Percent nonwhite	13.8	9.1	11.1
Percent of employed persons that are craftsmen and kindred workers	14.1	15.1	13.9
Percent of employed persons engaged in manufacturing	33.2	35.6	19.8
Percent professional, tech- nical and kindred workers	13.9	13.8	14.8

SOURCES: U.S. Bureau of the Census. Census of Population and Housing: 1970. Census Tracts, Final Report PHC (1)-215, Toledo, Ohio-Mich, SMSA. U.S. Government Printing Office. Washington, D.C., 1972.

U.S. Bureau of the Census, Statistical Abstract of the United States: 1976 (97th edition). Washington, D.C., 1976.

U.S. Bureau of the Census. 1970 Census of the Population, Characteristics of the Population, vol. 1, part 37 Ohio section 2. U.S. Government Printing Office, Washington, D.C., 1973.

U.S. Bureau of the Census. 1970 Census of the Population, Characteristics of the Population, vol. 1, part 1, U.S. Summary section 2. U.S. Government Printing Office, Washington, D.C., 1973.

and technical occupations was similar to the state percent, and both are only slightly lower than the United States as a whole. Perhaps the largest differential (except for percent in manufacturing) was percent nonwhite, 13.8 percent in Toledo versus 9.1 and 11.1 for Ohio and the United States, respectively. Overall, Toledo is largely an industrial/manufacturing city with a slightly lower socioeconomic structure than Ohio or the United States.

Sources of Data

The data for the present undertaking were derived from three sources. Since this research is taking an ecological approach, it was necessary for all infant deaths to be allocated to the census tract of mothers usual residence. Similarly, all live births occurring in each tract had to be known in order to calculate infant mortality rates. From the Bureau of Vital Statistics, Toledo Department of Health, data on infant deaths were collected for the periods January 1, 1949 to December 31, 1951 and January 1, 1969 to December 31, 1971. For each infant death, age, sex, race, cause of death, and census tract of mother's residence were obtained from the original death certificates. For the central census years 1950 and 1970, data on live births were collected for each tract from microfilm records.

The infant deaths and live births for the period January 1, 1959 to December 31, 1961 were obtained from data tapes provided by the Ohio Department of Health. In

calculating rates, the conventional procedure of relating the average number of deaths occurring during the three years for each time period covered to the number of live births in the central census year was followed. This was done to minimize the possible influences of chance fluctuations in the year to year number of infant deaths. This problem was described by Chase (National Center for Health Statistics, 1967b:19) who compared infant mortality cross culturally. She stated that:

. . . during periods of rapidly changing numbers of births, the computation of infant mortality rates based on deaths under 1 year and live births in the same calendar year gives biased estimates of the risk of death. If births are rising, the estimate of the risk of dying expressed by the infant mortality rate is artificially deflated. Conversely, the infant mortality rate is inflated in periods when births are declining rapidly.

Socioeconomic characteristics of the population in each census tract were obtained from the 1950, 1960, and 1970 Census of Population and Housing, Census Tract Statistics, published by the Bureau of the Census.

Variable Description

The census tract socioeconomic characteristics, the independent variables, as well as the dependent variables utilized in this study are described in this section. The independent variables (SES variables) were categorized into three groups: (1) economic status variables; (2) family status variables; and (3) housing status variables.

Independent Variables

Economic Status Variables

HIGH SCHOOL EDUCATION: Percent age 25 and over who are high school graduates.

WHITE COLLAR: Percent of employed persons age 16 and over who are employed in white collar occupations (professional, technical, managers, administrators, sales, clerical, and kindred workers).

INCOME: Median annual income of families and unrelated individuals.

Family Status Variables

UNEMPLOYED: Percent of labor force who are unemployed.

FEMALE LABOR FORCE: Percent of women 16 and over who are in the labor force.

MARITAL INSTABILITY: Percent of population age 14 and over widowed or divorced.

Housing Status Variables

CROWDING: Percent of dwelling units with 1.01 or more persons per room.

SINGLE UNITS: Percent of housing units that are single family housing units.

Race Variable (control variable)

NONWHITE: Percent of population who are nonwhite.

Dependent Variables

INFANT MORTALITY RATE (IMR): The average number of infant deaths in a three year period per 1,000 live

births during the central census year.

NEONATAL MORTALITY RATE (NMR): The average number of deaths of infants under 28 days of age in a three year period per 1,000 live births during the central census year.

POSTNEONATAL MORTALITY RATE (PMR): The average number of deaths of infants age one month to one year in a three year period per 1,000 live births during the central census year.

Research Procedures and Statistical Analysis

The study reported on in this thesis is based on data for residents of the city of Toledo, Ohio. The study population consisted of all live-born infants who died under one year of age during the three time periods 1949-51, 1959-61, and 1969-71. For all periods, conventional infant mortality rates were calculated by dividing the average number of deaths occurring annually during the three calendar years in question by the total number of live births occurring during the central census years (1950, 1960, and 1970). Rates were calculated for total infant deaths, for deaths occurring during the first month after birth (neonatal mortality), and for deaths occurring at ages 1 month to 1 year (postneonatal mortality). The census tract of mother's usual residence was taken as the basic unit of analysis, and the several independent socioeconomic variables were taken as indexes

of a tract's overall level of socioeconomic status.

Since the unit of this ecological approach of the investigation of the relationship between infant mortality and socioeconomic status is the census tract, a few paragraphs describing the census tract are in order.

The bureau of the Census defines the census tract as follows (U.S. Bureau of the Census, 1972, Appendix A:1):

Census tracts are small areas into which large cities and adjacent areas have been divided for statistical purposes. Tract boundaries were established cooperatively by a local committee and the Bureau of the Census. Tracts were generally designed to be relatively uniform with respect to population characteristics, economic status, and living conditions. The average tract has about 4,000 residents. Tract boundaries are established with the intention of being maintained over a long time so that comparisons may be made from census to census.

Historically, the census tract concept was developed by Dr. Walter Laidlaw in New York City in 1906. He felt the need for studying neighborhoods in cities using homogeneous units smaller than the ward or borough. The Bureau of the Census tabulated census tract data from the 1910 census for eight cities including New York City. The number of cities and adjacent areas tracted increased with each census year, and by 1970 there were 241 such tracted areas. All of these areas are termed Standard Metropolitan Statistical Areas (SMSA's) (U.S. Bureau of the Census, 1972, Appendix A:1-2).

As of 1970, the city of Toledo contained 86 census tracts. However, since SMSA's have been expanding, both in terms of the number of SMSA's and in terms of the size

of existing SMSA's, it was impossible to include all the tracts in the present analysis (e.g., some census tracts were added from 1950 to 1960, and from 1960 to 1970, so that complete tract comparability from one census to another does not exist). In order to have a direct comparison from census to census only the 53 census tracts that were the same for all three census years were utilized. Figure 3 shows the census tracts of the city of Toledo that were analyzed.

The data analysis for the investigation of the infant mortality/socioeconomic status relationship was divided into two distinct phases. The first phase utilized a social area approach in which census tracts were combined into four approximately equal groups according to their overall socioeconomic characteristics. Infant mortality rates were calculated for the four social areas in order to identify broad underlying patterns and trends in the relationship over the three time periods covered for each socioeconomic variable.

The second phase of the data analysis employed correlational and multiple regression techniques between census tract infant mortality rates and socioeconomic characteristics. The purpose of this second phase was to permit a more detailed examination of the overall infant mortality/socioeconomic status relationship and to identify the variable(s) that were contributing most to infant mortality for each time period. The data for this research was placed on tape and analyzed using the SPSS (Statistical Package for the Social Sciences)

FIGURE 3
CENSUS TRACTS OF TOLEDO, OHIO

system file.

Description of the Social Area Ranking Procedure

The census tracts in Toledo for the three time periods were ranked from high to low on each of the several socioeconomic variables. For each of the variables tracts were then combined into four groups so that approximately 25 percent of the tracts were in each group for each time period under investigation. The number of live births and infant deaths for each socioeconomic group of each independent variable were summed and the number of infant deaths were divided by three in order to obtain three year infant death averages. The infant death averages were then divided by the total number of births in the socioeconomic groups and then multiplied by 1,000 yielding an infant mortality rate for each respective social area. The neonatal and postneonatal mortality rates were calculated in the same way.

The ratio of the lowest to the highest group for each time period and the percent change over the twenty year period 1950-1970, as well as the percent change from 1950 to 1960 and 1960 to 1970, were calculated in order to identify infant mortality/socioeconomic status trends within and between time periods. These procedures were conducted for the total and white population. When comparing the white-nonwhite populations the same procedure was utilized except that two instead of four social rank groups were used with approximately

one-half of the tracts in each group. This had to be done because of the small number of nonwhite infant deaths. Four social rank groups for the nonwhite population would have yielded unreliable rates and perhaps several empty cells, especially for 1950 where the number of nonwhite infant deaths was especially small. Cause of death was also investigated with two socioeconomic groups based on income. A white-nonwhite comparison was made using endogeneous and exogeneous cause of death categories for infant, neonatal and post-neonatal mortality for the three time periods.

Correlation Analysis

The second phase of this research used correlation and regression analysis. Regression analysis can be viewed as an extension of correlation analysis and ". . . is both logically prior to and theoretically more important than that of correlation" (Blalock, 1972:361), because it actually brings forth what has been called the ultimate goal of science, that is, prediction. In this case, predicting the value of one variable from another.

Multiple regression is an extension of bivariate correlation to multivariate analysis. A simple correlation coefficient assesses the linear relationship between a single independent variable and a single dependent variable. Multiple regression, as described by Nie et al. (1975:8-9):

. . . allows the researcher to study the linear relationship between a set of independent variables and a dependent variable while taking into account the interrelationships

among the independent variables. The basic goal of multiple regression is to produce a linear combination of independent variables which will correlate as highly as possible with the dependent variable. This linear combination can then be used to "predict" values of the dependent variable, and the importance of each of the independent variables in that prediction can be assessed.

One important problem that arises in multiple regression analysis is that of defining the effect of each independent variable on the dependent variable (Cohen and Cohen, 1975:79). When a set of independent variables are highly interrelated, this problem is known as multicollinearity. This problem can be dealt with using a correlational approach.

Correlation analysis permits the researcher to know the nature of the relationship between two variables so one variable can be associated with another from the known value of that variable. It also measures more precisely the strength of the relationship of two variables. The correlation coefficient used in this research is the Pearson product-moment correlation coefficient (r) which indicates the strength of association between the two variables under investigation. This coefficient measures the amount of spread or scatter about the linear least squares equation. The Pearson correlation coefficient has a range from -1.0 to $+1.0$. If the dots on a scattergram form a straight line, the correlation coefficient will be $+1.0$ or -1.0 , depending on whether the relationship is positive or negative. Assuming linearity, r will be zero if the dots are scattered in a random fashion. Thus, the larger the magnitude of the

correlation coefficient (r), the better the fit of association between the two variables in question (Blalock, 1972). The correlation coefficient squared, or " r^2 " is interpreted as the proportion of variance in Y associated or shared with X and vice versa (Cohen and Cohen, 1975).

The two procedures that are fundamental to regression analysis are partial correlation and multiple correlation. Multiple correlation is a way of explaining the influence of a number of variables taken together on a dependent variable without controlling on any independent variables (Blalock, 1972; Kerlinger and Pedhazur, 1973). The multiple correlation coefficient is a summary statistic that indicates the overall association of a number of independent variables with a dependent variable.

"Partial correlation (pr) provides the researcher with a single measure of association describing the relationship between two variables while adjusting for the effects of one or more additional variables" (Nie et al., 1975:302). Partial correlation permits the researcher to remove the effect of a single control variable, or a number of control variables, and thus permit an estimate of the net impact of an independent variable on a dependent variable. It also permits the investigator to uncover any spurious relationships, to locate intervening variables, and it can help in making causal inferences (Nie et al., 1975). The squared partial correlation coefficient (pr^2) is interpreted as the proportion of that

part of the Y variance (dependent variable) which is independent of the remaining independent variable(s) accounted for uniquely by X (Cohen and Cohen, 1975:96).

The semipartial correlation coefficient expresses the correlation of an independent variable from which other independent variables have been partialled with the dependent variable. In other words, it is the correlation between all of Y and X_1 from which X_2 has been partialled. It is a semipartial correlation since the effects of X_2 have been removed from X_1 but not from Y. The effect of X_2 is taken out only from the independent variable X_1 by performing a simple linear regression of X_2 on X_1 , and then this residual of X_1 is correlated with the dependent variable. The semipartial correlation differs from the partial correlation in that the partial correlation the effect of X_2 is first taken out of both Y and X_1 , and then the resulting two residuals are correlated with each other (Nie et al., 1975, Cohen and Cohen, 1975).

The semipartial correlation squared (sr^2) is interpreted as the proportion of variance in the dependent variable (Y) uniquely associated with an independent variable (X_1); thus, sr^2 is the increase in the squared multiple correlation (R^2) when the independent variable (X_1) is added to the other independent variables ($X_2 \dots n$) (Cohen and Cohen, 1975).

In comparing the semipartial correlation squared and the partial correlation, Cohen and Cohen (1975:96) state

that:

It can be seen that pr^2 will virtually always be larger than and can never be smaller than sr^2 , since sr^2 is the unique contribution of X expressed as a proportion of the total Y variance while pr^2 expresses the same unique contribution of X as a proportion of that part of the Y variance not accounted for by the other independent variables.

Due to the relatively small size of the nonwhite population in Toledo, and the associated small number of infant deaths, especially in 1950, the correlation and multiple regression analyses could not be used for either a separate analysis of nonwhite infant mortality differentials or for a white-nonwhite comparison. Therefore percent nonwhite was used as a control variable in this phase of the analysis.

Each of the eight independent variables was associated with each of the three dependent variables and an r^2 , sr^2 , and pr^2 was computed for each relationship. Percent nonwhite was the control variable for each sr^2 and pr^2 . Variable sets were also employed in the semipartial analyses. The three variable sets were (1) economic status; (2) family status; and (3) housing status (see Variable Description section). Each dependent variable was associated with one variable set controlling on all combinations of the other two and percent nonwhite. Taking independent variables singularly and in sets should permit an intuitive grasp of the dynamics of importance, dominance, and explanatory power of socio-economic status on infant mortality for each of the three time periods under investigation.

Limitations of the Study

In studies of this type, basically two methodological unit approaches can be used. One approach is based on the collection and analysis of individual data. This type of analysis would be based on the specific characteristics of individual mothers, infants, and their families. The other approach (the one used in this research), is based upon aggregate or ecological data which are descriptive properties of an entire population residing in a specified geographic area, in this case the census tract. The basic limitation of this approach in recent years is revealed in the controversy over the utility and logic of ecological research (Robinson, 1950; Goodman, 1953; Duncan and Davis, 1953; Myers, 1954; Hawley and Duncan, 1957; Mabry, 1958; Annual meetings of the American Public Health Association, 1966; Dogan and Rokkan, 1967). The central issue involves the problem of making inferences about individual characteristics using aggregate data and committing what is known as the "ecological fallacy." This issue is rooted in the controversy over the extent to which census tracts are basically homogeneous, which is the fundamental assumption underlying the census tract concept noted by the Bureau of the Census, or whether census tracts are generally heterogeneous.

Stockwell and Nagi (1968:7), using the works of Shevky and Williams (1949) and Shevky and Bell (1955) as a basis, pointed out that the purpose of social area analysis is:

. . . not to analyze the causes of stratification and differentiation in contemporary American society, but merely to provide an analytical framework for the comparative study of certain aspects of social structure . . . Also, when social area analysis is used, the resulting study is no more than a statistical study of the differences that can be observed between areas that have been empirically delineated in terms of various objective criteria.

Furthermore, Stockwell and Nagi (1968) suggested that there is greater homogeneity within than between ecological units, and that this greater homogeneity within serves to differentiate them meaningfully in terms of objective criteria as income and occupational composition. Moreover, it would be reasonable to assume that differences in income and occupation might have a significant relationship to other differences that might exist between units as birth and death rates, household and family characteristics (p. 7).

Stockwell and Nagi (1968:7) concluded that:

It would thus seem that whether or not social rank areas are completely homogeneous is not of critical importance--as long as they can be differentiated from one another in relative terms.

Although many studies have noted associations between socioeconomic characteristics and demographic structures and/or changes using an ecological approach, it is not the purpose of this research to make such inferences from the aggregate to the individual level. However, as Kendall and Lazarsfeld (in Merton and Lazarsfeld, 1950:192) have stated, "the most common use of unit data is as a substitute for personal data which, for one reason or another, are not available."

Although there are problems with the use of ecological

data, ecological relationships are important, both theoretically and practically. Preston (1977:1) points out a main advantage of such studies, "namely that its geographic specificity provides a valuable guide to structuring local governmental programs of health care that are usually implemented on a geographic basis." From the public policy point of view, the findings of census tract research may have a great deal of significance since approximately two-thirds of the United States population lives within tracted SMSA's. It is also important to identify relationships as a step toward delineating variables to be included in studies using an individual approach. Furthermore, this study's concern with variations on a longitudinal design should provide a stronger basis for explanatory inferences using individual data in the future. Finally, it should be mentioned that the collection of data on an individual level for a study with the geographical scope and 20 year longitudinal design of this one, would be prohibitive from the point of view of both economics and time.

A second limitation is the small number of infant deaths in any given year in a city the size of Toledo. In order to compute reliable rates, three year infant death averages were used to control for year to year fluctuations. In studies of a limited area, as in the 53 census tract of Toledo, in contrast to larger cities, SMSA's, or larger ecological units as counties or states, the small number of

infant deaths persists especially since infant death rates have been consistently declining since the mid-1960's. However, from a local policy and program implementation point of view, ecological studies such as the present one are necessary because, as already mentioned, local government programs of health care are implemented on a geographic basis.

A third limitation in ecological studies using census tracts as the unit of analysis is the racial mixture of tracts. A primarily white census tract could have a small nonwhite percentage; thus, when white-nonwhite comparisons are being made the aggregate socioeconomic status of a tract may not be representative of the nonwhite population of the tract. This problem is impossible to control for given the nature of the data. However, there are two ways of dealing with this problem. One, we can accept the assumption of the Bureau of the Census that census tracts are more homogeneous within than between; and secondly, we can note that preliminary analysis of the present data indicated that socioeconomic status groups have become increasingly more distinct from 1950 to 1970 (Adamchak and Stockwell, 1978). This widening of the gap between social areas lends support to the notion that racial intermixture of tracts is not confounding the investigated relationships. Therefore, in spite of the limitations, we feel that this ecological approach provides a promising technique for examining the relationship between socioeconomic status characteristics of census tracts and their corresponding infant mortality rates.

CHAPTER IV

FINDINGS OF THE INVESTIGATION BETWEEN INFANT MORTALITY AND SOCIOECONOMIC STATUS

In this chapter, the results of the data analysis of the relationship between infant mortality and socioeconomic status are presented and interpreted. The chapter is divided into two major sections. The first section presents findings of the social area ranking approach for economic, family, and housing status variables as well as cause of death types. The major focus of this section was on social and economic group differences. The second section presents findings of the correlation analysis which primarily focused on squared semipartial correlations. These coefficients concentrated on the explanatory power of single variables and variable sets for the three time periods.

The three time periods under investigation yield a peculiar component percentage change for total, white and nonwhite infant mortality as shown in Table 11. For the white population, total infant and neonatal mortality rates declined consistently and markedly from 1950 to 1970, while the postneonatal rate remained unchanged between 1950 and 1960 and declined only slightly between 1960 and 1970. For nonwhites, on the other hand, all rates declined markedly between 1950 and 1960, but the 1960-70 decade saw a continued

TABLE 11

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES AND COMPONENT
PERCENTAGES: TOLEDO, OHIO, 1950, 1960, and 1970

Infant Mortality Components	1950		1960		1970	
	Rates	Component Percent- ages	Rates	Component Percent- ages	Rates	Component Percent- ages
<u>Total Population</u>						
Infant Mortality	26.5	100.0	24.2	100.0	21.0	100.0
Neonatal						
Mortality	20.5	77.3	18.4	76.2	14.2	67.7
Postneonatal						
Mortality	6.0	22.7	5.8	23.8	6.8	32.3
<u>White Population</u>						
Infant Mortality	25.0	100.0	22.6	100.0	17.4	100.0
Neonatal						
Mortality	19.6	78.4	17.2	76.1	12.3	70.7
Postneonatal						
Mortality	5.4	21.6	5.4	23.9	5.1	29.3
<u>Nonwhite Population</u>						
Infant Mortality	38.1	100.0	31.8	100.0	32.2	100.0
Neonatal						
Mortality	27.3	71.7	24.2	76.1	20.3	63.1
Postneonatal						
Mortality	10.8	28.3	7.6	23.9	11.9	36.9

neonatal decline offset by a sizeable increase in the post-neonatal mortality rate. This latter increase was so great that it resulted in a slight rise in the nonwhite total infant mortality rate during the most recent period. The exact significance of this increase is unclear, but may reflect the increase in the number and proportion of blacks, particularly lower socioeconomic status blacks, in the Toledo population. The net effect of these trends has been an overall marked decline in overall infant mortality, and especially neonatal mortality, while the postneonatal mortality rate has risen slightly.

Social Area Ranking

The social area ranking approach was divided into five sections. The first three consist of and describe economic, family and housing status variables, respectively. Infant, neonatal and postneonatal mortality rates were calculated for each independent variable for the three time periods for various socioeconomic groups. The fourth section briefly analyzes cause of death types (endogeneous and exogeneous causes), and a final section summarizes and discusses the major findings and compares them to other research findings.

Economic Status Rankings

The three variables considered in the economic status ranking were percent high school graduates, percent engaged in white collar occupations and median family income.

Tables 12 through 16 depict the association between education and infant mortality. An examination of Table 12 reveals that for the city as a whole the decline in infant mortality since 1950 has been accompanied by a pronounced widening of the socioeconomic differential. Although the inverse gradient is marred by some inconsistencies between Areas II and III, the differences between the highest and lowest education areas has steadily widened. The data in Table 12 further reveal that neonatal mortality has contributed most to this widening differential. That is, contrary to the expectations of those studies conducted a decade ago, the data for Toledo clearly indicate that the level of neonatal mortality is clearly related in an inverse manner to socioeconomic status as measured by the educational composition of the population. Although the trend with respect to post-neonatal mortality is slightly more erratic, it is also clear that this component of infant mortality continues to display a marked inverse relationship to socioeconomic status.

Turning to an examination of Tables 13-16, it is clear that the widening of this differential characterizes both whites and nonwhites for neonatal mortality, but that the inverse postneonatal relationship is largely a function of the substantially higher rate among low status nonwhites. When the four areas are compared for whites this association is seen to have declined since 1950 (Table 13); and when whites and nonwhites are compared in terms of two broad areas

TABLE 12

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT
AGE 25 AND OVER WITH A HIGH SCHOOL EDUCATION: TOTAL POPULA-
TION, TOLEDO, OHIO, 1950, 1960 and 1970

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	21.64 (13)	18.42 (14)	14.28 (12)	-14.9	-22.5	-34.0
II	24.64 (15)	25.63 (14)	20.54 (13)	+3.9	-19.9	-16.6
III	27.44 (12)	25.26 (12)	20.48 (14)	-7.9	-18.9	-25.4
IV (low)	33.69 (13)	30.04 (13)	32.42 (14)	-10.8	+7.3	-3.8
Ratio (IV:I)	1.56	1.63	2.27			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	18.41 (13)	14.58 (14)	9.52 (12)	-20.8	-34.7	-48.3
II	19.16 (15)	20.15 (14)	14.98 (13)	+4.9	-25.7	-21.8
III	20.90 (12)	18.48 (12)	13.43 (14)	-11.6	-28.3	-35.7
IV (low)	24.38 (13)	21.91 (13)	21.21 (14)	-10.1	-3.2	-13.0
Ratio (IV:I)	1.32	1.50	2.23			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	3.23 (13)	3.84 (14)	4.76 (12)	+15.9	+19.3	+32.1
II	5.48 (15)	5.48 (14)	5.56 (13)	0.0	+1.4	+1.4
III	6.54 (12)	6.78 (12)	7.05 (14)	+3.5	+3.8	+7.2
IV (low)	9.31 (13)	8.13 (13)	11.21 (14)	-12.7	+27.5	+16.9
Ratio (IV:I)	2.88	2.12	2.36			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 13

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT
AGE 25 AND OVER WITH A HIGH SCHOOL EDUCATION: WHITE POPULA-
TION, TOLEDO, OHIO, 1950, 1960 and 1970

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	21.54 (13)	18.37 (14)	13.32 (12)	-14.7	-27.5	-38.2
II	24.28 (15)	25.27 (14)	18.48 (13)	+3.9	-29.6	-23.9
III	27.38 (12)	23.23 (12)	18.72 (14)	-15.2	-19.4	-31.6
IV (low)	29.01 (13)	27.24 (13)	20.63 (14)	-6.1	-24.3	-28.9
Ratio (IV:I)	1.35	1.48	1.55			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-38.5%
I (high)	18.29 (13)	14.48 (14)	9.04 (12)	-20.8	-37.6	-50.6
II	18.73 (15)	20.03 (14)	14.18 (13)	+6.5	-29.2	-24.3
III	21.17 (12)	16.84 (12)	11.78 (14)	-20.5	-30.0	-44.4
IV (low)	21.60 (13)	19.11 (13)	15.20 (14)	-11.5	-20.5	-29.6
Ratio (IV:I)	1.18	1.32	1.68			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	3.25 (13)	3.89 (14)	4.28 (12)	+16.5	+9.1	+24.1
II	5.55 (15)	5.24 (14)	4.30 (13)	-5.6	-17.9	-22.5
III	6.21 (12)	6.39 (12)	6.94 (14)	+2.8	+7.9	+10.5
IV (low)	7.41 (13)	8.13 (13)	5.43 (14)	+8.9	-33.2	-26.7
Ratio (IV:I)	2.28	2.09	1.27			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 14

INFANT MORTALITY RATES BY PERCENT AGE 25 AND OVER WITH A HIGH SCHOOL EDUCATION: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	23.31	21.59	16.56	-7.4	-23.3	-29.0
II (low)	30.76	27.69	27.95	-10.0	+1.0	-9.1
Ratio (II:I)	1.32	1.28	1.69			
<u>White Population</u>						
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	23.02	21.10	15.12	-8.3	-28.3	-34.3
II (low)	28.14	24.90	22.11	-11.5	-11.2	-21.4
Ratio (II:I)	1.22	1.18	1.46			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	26.71	24.55	-	-8.1	-
II (low)	-	33.58	37.43	-	+10.3	-
Ratio (II:I)	-	1.26	1.52			

*The high SES group is composed of 28 census tracts and the low SES group 25 census tracts.

TABLE 15

NEONATAL MORTALITY RATES BY PERCENT AGE 25 AND OVER WITH A HIGH SCHOOL EDUCATION: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	18.83	17.03	11.42	-9.6	-32.9	-39.4
II (low)	22.75	20.22	18.58	-11.1	-8.1	-18.3
Ratio (II:I)	1.21	1.19	1.63			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	18.53	16.67	10.70	-10.0	-35.8	-42.3
II (low)	21.37	17.79	15.38	-16.8	-13.5	-28.0
Ratio (II:I)	1.15	1.07	1.44			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	20.78	15.34	-	-26.2	-
II (low)	-	25.37	23.78	-	-6.3	-
Ratio (II:I)	-	1.22	1.55			

*The high SES group is composed of 28 census tracts and the low group 25 census tracts.

TABLE 16

POSTNEONATAL MORTALITY RATES BY PERCENT AGE 25 AND OVER WITH
A HIGH SCHOOL EDUCATION: TOTAL, WHITE AND NONWHITE POPULATION,
TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	4.48	4.56	5.14	+1.8	+11.3	+12.8
II (low)	8.01	7.47	9.37	-6.7	+20.3	+14.5
Ratio (II:I)	1.79	1.64	1.82			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.49	4.43	4.42	-1.3	-0.2	-1.6
II (low)	6.77	7.11	6.73	+4.8	-5.3	-0.6
Ratio (II:I)	1.51	1.60	1.52			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-29.7%	+36.2%	+9.1%
I (high)	-	5.93	9.21	-	+35.6	-
II (low)	-	8.21	13.65	-	+39.9	-
Ratio (II:I)	-	1.38	1.48			

*The high SES group is composed of 28 census tracts and the low SES group 25 census tracts.

the white differential is seen to have remained relatively stable while the nonwhite differential has increased slightly (Table 16).

Aside from the fact that the nonwhite postneonatal mortality situation clearly indicates that the well-being of this segment of the population is more adversely affected by exogeneous environmental conditions, the most compelling observation to be drawn from these tables concerns neonatal mortality. Contrary to those earlier studies that postulated a narrowing of the overall differential as neonatal mortality declined (Willie, 1959; Stockwell, 1962a), it has been the emergence of a pronounced inverse association between neonatal mortality and socioeconomic status that has contributed most to the widening of the overall differential.

The same general conclusions apply to the relationship between socioeconomic status and infant mortality when the former is defined in terms of either the occupational composition of the labor force (Tables 17-21) or in terms of family income (Tables 22-26). The various trends and patterns are slightly more erratic when occupation is used (which is not surprising since both Stockwell (1961) and Kitagawa and Hauser (1973) have shown that occupation is the least reliable indicator of socioeconomic status); and they are somewhat more pronounced when income is used (thus supporting the conclusions of others (Willie, 1959; Stockwell, 1962a) that income is the most sensitive socioeconomic measure with respect to mortality differentials).

TABLE 17

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT OF
LABOR FORCE ENGAGED IN WHITE COLLAR OCCUPATIONS: TOTAL POPULATION,
TOLEDO, OHIO, 1950, 1960 and 1970

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	23.07(11)	17.13(12)	14.44(13)	-25.7	-15.7	-37.4
II	24.53(14)	27.33(13)	18.95(12)	+10.2	-30.7	-22.7
III	27.09(13)	23.20(13)	24.56(14)	-14.4	+5.5	-9.3
IV (low)	30.66(15)	29.15(15)	28.37(14)	-4.9	-2.7	-7.5
Ratio (IV:I)	1.33	1.70	1.96			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	19.35(11)	13.18(12)	13.00(12)	-31.9	-25.4	-49.2
II	19.74(11)	22.36(13)	17.69(14)	+11.7	-41.9	-34.1
III	20.27(13)	17.40(13)	17.77(14)	-14.2	+1.6	-12.7
IV (low)	22.43(15)	21.00(15)	1.81	-6.4	-15.4	-20.8
Ratio (IV:I)	1.16	1.59				

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	3.72(11)	3.95(12)	4.61(13)	+5.8	+14.3	+19.3
II	4.79(11)	4.97(13)	5.95(12)	+3.6	+16.5	+19.5
III	6.82(13)	5.80(13)	6.87(14)	-15.0	+15.6	+0.7
IV (low)	8.23(15)	8.15(15)	10.60(14)	-1.0	+23.1	+22.4
Ratio (IV:I)	2.21	2.06	2.30			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 18

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT OF
LABOR FORCE ENGAGED IN WHITE COLLAR OCCUPATIONS: WHITE POPULATION
TOLEDO, OHIO, 1950, 1960 and 1970

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	22.92(11)	17.23(12)	13.15(13)	-24.8	-23.7	-42.6
II	24.38(14)	26.83(13)	19.20(12)	+9.1	-28.4	-21.2
III	26.04(13)	22.15(13)	21.98(14)	-14.9	-0.8	-15.6
IV (low)	26.85(15)	26.54(15)	17.33(14)	-1.2	-34.7	-35.5
Ratio (IV:I)	1.17	1.54	1.32			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	19.18(11)	14.36(12)	9.25(13)	-25.1	-35.6	-51.8
II	19.43(14)	22.08(13)	13.04(12)	+12.0	-40.9	-32.9
III	19.53(13)	16.38(13)	16.79(14)	-16.1	+2.4	-14.0
IV (low)	20.48(15)	18.18(15)	11.56(14)	-11.2	-36.4	-43.6
Ratio (IV:I)	1.07	1.27	1.25			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	3.74(11)	2.87(12)	3.90(13)	-23.3	+26.4	+4.1
II	4.95(14)	4.75(13)	6.16(12)	-4.0	+22.9	+19.6
III	6.51(13)	5.77(13)	5.19(14)	-11.4	-10.1	-20.3
IV (low)	6.37(15)	8.36(15)	5.77(14)	+23.8	-31.0	-9.4
Ratio (IV:I)	1.70	2.91	1.48			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 19

INFANT MORTALITY RATES BY PERCENT OF LABOR FORCE ENGAGED IN WHITE
COLLAR OCCUPATIONS: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO,
OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	23.91	21.76	16.59	-9.0	-23.8	-30.6
II (low)	28.96	26.44	26.40	-8.7	-0.2	-8.8
Ratio (II:I)	1.21	1.22	1.59			
<u>White Population</u>						
City Total	24.98	22.58	16.40	-9.6%	-22.9%	-30.3%
I (high)	23.74	21.52	16.22	-9.4	-24.6	-31.7
II (low)	26.40	23.85	19.78	-9.7	-17.1	-25.1
Ratio (II:I)	1.11	1.11	1.22			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	31.68	19.17	-	-39.5	-
II (low)	-	32.23	36.57	-	+11.9	-
Ratio (II:I)	-	1.02	1.71			

*The high SES group is composed of 25 census tracts and the low
SES group 28 census tracts.

TABLE 20

NEONATAL MORTALITY RATES BY PERCENT OF LABOR FORCE ENGAGED IN
WHITE COLLAR OCCUPATIONS: TOTAL, WHITE AND NONWHITE POPULATION,
TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	19.57	17.35	11.34	-11.3	-34.6	-42.1
II (low)	21.40	19.36	17.73	-9.5	-8.4	-17.1
Ratio (II:I)	1.09	1.12	1.56			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	19.32	17.81	11.17	-7.8	-37.3	-42.2
II (low)	19.95	17.08	14.31	-14.4	-16.2	-28.3
Ratio (II:I)	1.03	.96	1.28			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	25.14	12.50	-	-50.3	-
II (low)	-	23.39	22.98	-	-1.8	-
Ratio (II:I)	-	.93	1.84			

*The high SES group is composed of 25 census tracts and the low
SES group 28 census tracts.

TABLE 21

POSTNEONATAL MORTALITY RATES BY PERCENT OF LABOR FORCE ENGAGED
IN WHITE COLLAR OCCUPATIONS: TOTAL, WHITE AND NONWHITE POPULA-
TION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	4.34	4.41	5.25	+1.6	+16.0	+17.3
II (low)	7.56	7.08	8.67	-6.3	+18.3	+12.8
Ratio (II:I)	1.74	1.61	1.65			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.42	3.71	5.05	-16.3	+26.5	+12.3
II (low)	6.45	6.77	5.47	+4.7	-19.2	-15.2
Ratio (II:I)	1.46	1.82	1.08			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-29.7%	+36.2%	+9.1%
I (high)	-	6.54	6.67	-	+1.9	-
II (low)	-	8.84	13.59	-	+35.0	-
Ratio (II:I)	-	1.35	2.04			

*The high SES group is composed of 25 census tracts and the low
SES group 28 census tracts.

TABLE 22

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY MEDIAN FAMILY
INCOME GROUPINGS: TOTAL POPULATION, TOLEDO, OHIO, 1950, 1960
AND 1970

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	22.99 (12)	16.65 (13)	12.69 (13)	-27.6	-23.8	-44.8
II	27.65 (16)	25.55 (15)	18.90 (14)	-7.6	-26.0	-31.6
III	25.07 (12)	24.97 (12)	22.29 (11)	-9.4	-10.7	-11.1
IV (low)	29.33 (13)	30.63 (13)	32.69 (15)	+4.2	+6.3	+10.3
Ratio (IV:I)	1.28	1.84	2.58			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	18.62 (12)	12.75 (13)	8.40 (13)	-31.5	-34.1	-54.9
II	21.92 (16)	19.98 (15)	14.29 (14)	-8.9	-28.5	-34.8
III	19.65 (12)	19.17 (12)	15.36 (11)	-2.4	-19.9	-21.8
IV (low)	21.39 (13)	22.42 (13)	20.43 (15)	+4.6	-8.9	-4.5
Ratio (IV:I)	1.15	1.76	2.43			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	4.37 (12)	3.90 (13)	4.29 (13)	-10.8	+9.1	-1.8
II	5.73 (16)	5.57 (15)	4.61 (14)	-2.8	-17.2	-19.5
III	5.42 (12)	5.80 (12)	6.93 (11)	+6.6	+16.3	+21.8
IV (low)	7.94 (13)	8.21 (13)	12.26 (15)	+3.3	+33.0	+35.2
Ratio (IV:I)	1.82	2.11	2.86			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 23

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY MEDIAN FAMILY
INCOME GROUPINGS: WHITE POPULATION, TOLEDO, OHIO, 1950, 1960
AND 1970

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	23.05 (12)	16.73 (13)	12.99 (13)	-27.4	-22.4	-43.6
II	27.22 (16)	24.94 (15)	16.81 (14)	-8.4	-32.6	-38.2
III	23.64 (12)	24.27 (12)	21.81 (11)	+2.6	-10.1	-7.7
IV (low)	25.76 (13)	28.03 (13)	22.00 (15)	+8.1	-21.5	-14.6
Ratio (IV:I)	1.12	1.68	1.69			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
II (high)	18.67 (12)	12.77 (13)	8.52 (13)	-31.6	-33.3	-54.4
II	21.98 (16)	19.51 (15)	13.33 (14)	-11.2	-31.7	-39.4
III	18.68 (12)	18.61 (12)	14.75 (11)	-0.4	-20.7	-21.0
IV (low)	18.66 (13)	19.71 (13)	15.40 (15)	+5.3	-21.9	-17.5
Ratio (IV:I)	1.00	1.54	1.81			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.38 (12)	3.96 (13)	4.47 (13)	-9.6	+11.4	+2.0
II	5.24 (16)	5.43 (15)	3.48 (14)	+3.5	-35.9	-33.6
III	4.96 (12)	5.66 (12)	7.06 (11)	+12.4	+19.8	+29.7
IV (low)	7.10 (16)	8.32 (13)	6.60 (15)	+14.7	-20.7	-7.0
Ratio (IV:I)	1.62	2.10	1.48			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 24

INFANT MORTALITY RATES BY MEDIAN FAMILY INCOME GROUPINGS: TOTAL,
WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	25.50	20.92	15.79	-18.0	-24.5	-38.1
II (low)	27.48	27.95	27.44	+1.7	-1.8	-0.1
Ratio (II:I)	1.08	1.34	1.74			
<u>White Population</u>						
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	25.28	20.61	14.68	-18.5	-28.8	-41.9
II (low)	24.65	26.04	22.00	+5.3	-15.5	-10.8
Ratio (II:I)	.98	1.26	1.50			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	31.15	22.51	-	-27.7	-
II (low)	-	31.81	36.92	-	+13.8	-
Ratio (II:I)	-	1.02	1.64			

*The high SES group is composed of 28 census tracts and the low
SES group 25 census tracts.

TABLE 25

NEONATAL MORTALITY RATES BY MEDIAN FAMILY INCOME GROUPINGS: TOTAL,
WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	20.40	16.22	11.36	-20.5	-30.0	-44.3
II (low)	20.64	20.88	17.73	+1.1	-15.1	-14.1
Ratio (II:I)	1.01	1.29	1.56			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	20.44	15.96	10.71	-21.9	-32.9	-47.6
II (low)	18.68	19.36	14.87	+3.7	-23.2	-20.4
Ratio (II:I)	.91	1.21	1.39			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	24.92	15.25	-	-38.8	-
II (low)	-	24.08	22.72	-	-5.6	-
Ratio (II:I)	-	.97	1.49			

*The high SES group is composed of 28 census tracts and the low
SES group 25 census tracts.

TABLE 26

POSTNEONATAL MORTALITY RATES BY MEDIAN FAMILY INCOME GROUPINGS:
TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960
AND 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	-14.9%	+11.2%
I (high)	5.10	4.70	4.43	-7.8	-5.7	-13.1
II (low)	6.84	7.07	9.71	+3.3	+27.2	+29.6
Ratio (II:I)	1.34	1.50	2.19			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.84	4.65	3.97	-3.9	-14.6	-18.0
II (low)	5.97	6.68	7.13	+10.6	+6.3	+16.3
Ratio (II:I)	1.23	1.44	1.80			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-29.7%	+36.2%	+9.1%
I (high)	-	6.23	7.26	-	+14.2	-
II (low)	-	7.73	14.20	-	+45.6	-
Ratio (II:I)	-	1.24	1.96			

*The high SES group is composed of 28 census tracts and the low SES group 25 census tracts.

However, for both variables, it is clear that the trend since 1950 has been for a widening of the overall socioeconomic/infant mortality differential, and that the major factor contributing to this trend has been the emergence of a marked inverse relationship between socioeconomic status and neonatal mortality.

Family Status Rankings

The family status variables used to rank social areas for the three time periods were percent of the labor force who were unemployed, percent of women age 16 and over who were in the labor force, and percent of the population age 16 and over who were widowed or divorced.

Tables 27 through 31 represent the association between infant mortality and the unemployment variable. Table 27 indicates that for the total population an inverse and widening socioeconomic relationship existed from 1950 to 1970 (although there was a slight inconsistency between Areas II and III in 1960). Although there were some inconsistencies in the 1960 and 1970 postneonatal gradients, both neonatal and post-neonatal mortality contributed to the overall infant mortality differential. This once again contradicts those studies that indicated that neonatal mortality was not sensitive with socioeconomic measures. This trend was also evidenced in the white population (Table 28), but to a lesser extent which indicates that the nonwhite population (Tables 29-31) contributed more than the white population to the overall widening differential

TABLE 27

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT
UNEMPLOYED: TOTAL POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (High)	22.40 (12)	18.51 (11)	11.65 (8)	-17.4	-37.1	-48.0
II	24.49 (15)	25.20 (16)	16.53 (16)	+2.8	-34.4	-32.5
III	26.19 (12)	20.86 (13)	21.80 (14)	-20.4	+4.3	-16.8
IV (low)	31.43 (14)	32.06 (15)	30.88 (15)	+2.0	-3.7	-1.7
Ratio (IV:I)	1.40	1.73	2.65			
Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	18.26 (12)	14.04 (11)	8.43 (8)	-23.1	-53.8	-53.8
II	19.74 (15)	19.43 (16)	9.88 (16)	-1.6	-49.2	-49.9
III	20.17 (12)	16.57 (13)	16.15 (14)	-17.8	-2.5	-20.0
IV (low)	23.03 (14)	23.41 (13)	20.66 (15)	+1.6	-11.7	-10.3
Ratio (IV:I)	1.26	1.67	2.45			
Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	4.14 (12)	4.47 (11)	3.22 (8)	+7.2	-28.0	-22.2
II	4.75 (15)	5.77 (16)	6.65 (16)	+17.7	+13.2	+28.6
III	6.02 (12)	4.29 (13)	5.65 (14)	-28.7	+24.1	-6.1
IV (low)	8.40 (14)	8.65 (13)	10.22 (15)	+2.9	+15.4	+17.8
Ratio (IV:I)	2.03	1.94	3.17			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 28

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT
UNEMPLOYED: WHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	22.25 (12)	18.43 (11)	11.06 (8)	-17.2	-40.0	-50.3
II	24.52 (15)	25.03 (16)	15.28 (16)	+2.0	-39.0	-37.7
III	25.34 (12)	20.00 (13)	22.05 (14)	-21.1	+0.3	-13.0
IV (low)	28.10 (14)	32.67 (13)	20.44 (15)	+14.0	-37.4	-27.3
Ratio (IV:I)	1.26	1.77	1.85			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	18.10 (12)	14.29 (11)	8.60 (8)	-21.0	-39.8	-52.5
II	19.92 (15)	19.27 (16)	9.08 (16)	-3.3	-52.9	-54.4
III	19.79 (12)	15.88 (13)	16.06 (14)	-19.8	+1.1	-18.8
IV (low)	20.62 (14)	22.70 (13)	16.46 (15)	+9.2	-27.5	-20.2
Ratio (IV:I)	1.14	1.59	1.91			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.15 (12)	4.14 (11)	2.46 (8)	-0.2	-40.6	-40.7
II	4.60 (15)	5.76 (16)	6.20 (16)	+20.1	+7.1	+25.8
III	5.55 (12)	4.12 (13)	5.99 (14)	-25.8	+31.2	+7.3
IV (low)	7.48 (14)	9.97 (13)	3.98 (15)	+25.0	-60.1	-46.8
Ratio (IV:I)	1.80	2.41	1.62			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 29

INFANT MORTALITY RATES BY PERCENT UNEMPLOYED: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	23.57	21.95	15.02	-6.9	-31.6	-36.3
II (low)	29.23	26.43	25.08	-9.6	-1.3	-10.8
Ratio (II:I)	1.24	1.20	1.74			
<u>White Population</u>						
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	23.53	21.80	13.87	-7.4	-36.4	-41.1
II (low)	26.68	23.43	21.57	-12.2	-7.9	-19.2
Ratio (II:I)	1.13	1.07	1.56			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	25.78	25.94	-	-6.6	-
II (low)	-	32.04	33.89	-	+5.5	-
Ratio (II:I)	-	1.15	1.31			

*The high SES group is composed of 27 census tracts and the low SES group 26 census tracts in 1950 and 1960. In 1970, 24 and 29 census tracts were used for the high and low SES groups, respectively.

TABLE 30

NEONATAL MORTALITY RATES BY PERCENT UNEMPLOYED: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-39.8%
I (high)	19.09	16.81	9.44	-11.9	-43.8	-50.5
II (low)	21.83	19.97	18.28	-8.5	-8.5	-16.3
Ratio (II:I)	1.14	1.19	1.94			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	19.13	16.83	8.93	-12.0	-47.9	-53.3
II (low)	20.19	17.72	16.18	-12.2	-8.7	-19.9
Ratio (II:I)	1.06	1.05	1.81			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	23.81	14.27	-	-40.1	-
II (low)	-	24.17	21.91	-	-9.4	-
Ratio (II:I)	-	1.02	1.54			

*The high SES group is composed of 27 census tracts and the low SES group 26 census tracts in 1950 and 1960. In 1970, 24 and 29 census tracts were used for the high and low SES groups, respectively.

TABLE 31

POSTNEONATAL MORTALITY RATES BY PERCENT UNEMPLOYED: TOTAL, WHITE
AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	4.48	5.14	5.58	+12.8	+7.9	+19.7
II (low)	7.40	6.46	7.80	-12.7	+17.2	+5.1
Ratio (II:I)	1.67	1.12	1.15			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.40	4.97	4.94	+11.5	-0.6	+10.9
II (low)	6.49	5.71	5.39	-12.0	-5.6	-16.9
Ratio (II:I)	1.48	1.15	1.09			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-29.7%	+36.2%	+9.1%
I (high)	-	3.97	11.67	-	+66.0	-
II (low)	-	7.87	11.98	-	+34.3	-
Ratio (II:I)	-	1.98	1.03			

*The high SES group is composed of 27 census tracts and the low SES group 26 census tracts in 1950 and 1960. In 1970, 24 and 29 census tracts were used for the high and low SES groups, respectively.

as evidenced by the far greater and even increasing nonwhite rates.

Female labor force participation exhibited an unusual pattern. It was hypothesized that high female labor force participation would result in a higher status due to increased family income. This was not the case. Both high and low status tracts as ranked on other variables were intermixed in the female labor force participation distribution. That is, a high status tract as ranked by other variables could appear as a high status tract on female labor force participation but so could a low status tract ranked on other indicators. For example, a predominately nonwhite tract that ranked extremely low on income or education could rank high on female labor force participation since the characteristics of nonwhite families include a matriarchal family structure with the mother/wife head of household being gainfully employed. Conversely, a high status tract ranked by income or education could rank low on female labor force participation since wives of businessmen, or anyone with a high income may not be employed. This caused the social area ranking of this variable to be peculiar as evidenced by many low-high ratios being less than 1.00.

As originally hypothesized, female labor force participation resulted in higher socioeconomic status. This seems to have been the case for the total population (Table 32) in 1950 for total infant and postneonatal mortality (ratios

TABLE 32

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT FEMALE
LABOR FORCE PARTICIPATION: TOTAL POPULATION, TOLEDO, OHIO, 1950,
1960 AND 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	27.19 (11)	26.87 (14)	31.92 (12)	-1.2	+15.8	+14.8
II	27.43 (15)	23.18 (17)	16.51 (12)	-15.5	-28.8	-39.9
III	23.26 (12)	23.26 (10)	17.41 (12)	0.0	-25.2	-25.2
IV (low)	27.59 (15)	23.27 (12)	18.68 (17)	-15.7	-19.7	-32.3
Ratio (IV:I)	1.01	.87	.59			
Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	21.01 (11)	20.98 (14)	20.79 (12)	-0.1	-0.9	-1.0
II	21.75 (15)	18.00 (17)	12.81 (12)	-17.2	-28.8	-41.1
III	18.70 (12)	18.09 (10)	10.50 (12)	-3.3	-42.0	-43.9
IV (low)	20.27 (15)	15.92 (12)	12.95 (17)	-21.5	-18.7	-36.1
Ratio (IV:I)	.96	.76	.62			
Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	6.18 (11)	5.89 (14)	11.13 (12)	-4.7	+47.1	+44.5
II	5.68 (15)	5.18 (17)	3.70 (12)	-8.8	-28.6	-34.9
III	4.56 (12)	5.17 (10)	6.91 (12)	+11.8	+25.2	+34.0
IV (low)	7.12 (15)	7.35 (12)	5.73 (17)	+3.1	-22.0	-19.5
Ratio (IV:I)	1.15	1.25	.52			

*Numbers in parentheses are the number of census tracts in each social area.

1.01 and 1.15, respectively), and in 1960 for postneonatal mortality (ratio of 1.25). However, in 1960 and 1970 Social Area I (high) had the highest infant and neonatal mortality rates as did postneonatal mortality in 1970. The original hypothesis also seems to apply to the entire white population (Table 33) since eleven of the twelve ratios were 1.00 or higher and there was some resemblance of inverse gradients (although not perfect). For the total and white population the 1950-70 percent changes declined in most cases, but the greatest gains (decreases in component mortality rates) were among the low social areas (Areas III and IV). White-nonwhite comparisons were not statistically feasible on this variable because most nonwhites were in the high social area. There were not enough cases in the low social area for the above mentioned reasons.

The final variable in the family status section is marital instability--percent age 14 and over widowed or divorced. For the total population (Table 34) in 1960 and 1970 a clear cut inverse gradient existed for total infant, neonatal and postneonatal mortality. All mortality ratios sharply increased from 1950 to 1970. A slight erratic pattern existed in 1950. Both the white (Table 35) and nonwhite (Tables 36-38) populations experienced an increase in relationship from 1950 to 1970. This increasing trend differential exhibited by both racial groups was felt hardest by the lower socioeconomic segments of the population. The lower social areas component percent changes either decreased slightly or increased indicating the

TABLE 33

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT FEMALE
LABOR FORCE PARTICIPATION: WHITE POPULATION, TOLEDO, OHIO, 1950,
1960 AND 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	21.54 (11)	20.67 (15)	17.32 (12)	-4.0	-16.2	-19.6
II	27.78 (15)	21.85 (17)	16.76 (12)	-21.3	-23.3	-39.7
III	22.52 (12)	23.62 (10)	17.47 (12)	+4.7	-26.0	-22.4
IV (low)	25.88 (15)	23.38 (12)	17.59 (17)	-9.7	-24.8	-32.0
Ratio (IV:I)	1.20	1.13	1.02			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-70	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	16.85 (11)	16.32 (14)	12.99 (12)	03.1	-20.4	-22.9
II	22.26 (15)	17.00 (17)	13.17 (12)	-23.6	-22.5	-40.8
III	18.06 (12)	18.32 (10)	10.99 (12)	+1.4	-40.0	-39.1
IV (low)	19.61 (15)	16.37 (12)	12.18 (17)	-16.5	-25.6	-37.9
Ratio (IV:I)	1.16	1.00	.94			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.68 (11)	4.35 (14)	4.33 (12)	-7.1	-0.5	-7.5
II	5.52 (15)	4.85 (17)	3.59 (12)	-21.1	-26.0	-35.0
III	4.46 (12)	5.30 (10)	6.48 (12)	+15.8	+18.2	+31.2
IV (low)	6.27 (15)	7.01 (12)	5.41 (17)	+10.6	-22.8	-13.7
Ratio (IV:I)	1.34	1.61	1.25			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 34

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT AGE
14 AND OVER WIDOWED OR DIVORCED: TOTAL POPULATION, TOLEDO, OHIO,
1950, 1960 AND 1970*

		Infant Deaths					
Social Rank	per 1,000 Live Births				% Change	% Change	% Change
Area	1950	1960	1970	1950-60	1960-70	1950-70	
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%	
I (high)	27.74 (17)	19.62 (11)	12.85 (10)	-29.3	-34.5	-53.7	
II	24.30 (12)	23.94 (15)	16.68 (10)	-1.5	-30.3	-31.4	
III	23.96 (10)	25.42 (12)	21.98 (18)	+5.7	-13.7	-8.4	
IV (low)	30.55 (14)	28.23 (15)	31.13 (15)	-7.6	+9.3	+1.9	
Ratio (IV:I)	1.10	1.44	2.42				
		Neonatal Deaths					
Social Rank	per 1,000 Live Births				% Change	% Change	% Change
Area	1950	1960	1970	1950-60	1960-70	1950-70	
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%	
I (high)	21.70 (17)	15.54 (11)	8.31 (10)	-28.4	-46.5	-61.7	
II	17.92 (12)	18.05 (15)	12.19 (10)	+0.7	-32.5	-32.0	
III	20.64 (10)	19.38 (12)	16.23 (12)	-6.1	-16.3	-21.4	
IV (low)	23.71 (14)	20.93 (15)	18.42 (15)	-11.7	-12.0	-22.3	
Ratio (IV:I)	1.09	1.35	2.22				
		Postneonatal Deaths					
Social Rank	per 1,000 Live Births				% Change	% Change	% Change
Area	1950	1960	1970	1950-60	1960-70	1950-70	
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%	
I (high)	6.04 (17)	4.08 (11)	4.54 (10)	-32.5	+10.1	-24.8	
II	6.38 (12)	5.89 (15)	4.49 (10)	-7.7	-23.8	-29.6	
III	3.32 (10)	6.04 (12)	5.71 (18)	+45.1	-5.5	+41.9	
IV (low)	6.84 (14)	7.30 (15)	12.71 (15)	+6.3	+42.6	+46.2	
Ratio (IV:I)	1.12	1.79	2.80				

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 35

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT AGE
14 AND OVER WIDOWED OR DIVORCED: WHITE POPULATION, TOLEDO, OHIO,
1950, 1960 AND 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	27.34 (17)	19.67 (11)	13.48 (10)	-28.1	-31.5	-50.7
II	23.29 (12)	22.97 (15)	14.21 (10)	-1.4	-38.1	-39.0
III	24.18 (10)	23.39 (12)	17.58 (18)	-3.3	-24.8	-27.3
IV (low)	27.39 (14)	25.46 (15)	25.61 (15)	-7.0	+0.6	-6.5
Ratio (IV:I)	1.00	1.29	1.90			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	21.58 (17)	15.54 (11)	8.61 (10)	-28.0	-44.6	-60.1
II	17.68 (12)	17.47 (15)	10.15 (10)	-1.2	-41.9	-42.6
III	20.83 (10)	17.54 (12)	13.69 (18)	-15.8	-21.9	-34.3
IV (low)	21.36 (14)	18.73 (15)	16.37 (15)	-12.3	-12.6	-23.4
Ratio (IV:I)	.99	1.21	1.90			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	5.76 (17)	4.13 (11)	4.88 (10)	-28.3	+15.4	-15.3
II	5.61 (12)	5.50 (15)	4.06 (10)	-2.0	-26.2	-27.6
III	3.35 (10)	5.85 (12)	3.89 (18)	+42.7	-33.5	+13.9
IV (low)	6.03 (14)	6.73 (15)	9.24 (15)	+10.4	+27.2	+34.7
Ratio (IV:I)	1.05	1.63	1.89			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 36

INFANT MORTALITY RATES BY PERCENT AGE 14 AND OVER WIDOWED OR
 DIVORCED: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO,
 1950, 1960 AND 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	26.36	21.77	15.94	-17.4	-26.8	-39.5
II (low)	27.94	26.88	27.51	-3.8	+2.3	-1.5
Ratio (II:I)	1.06	1.23	1.73			
<u>White Population</u>						
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	24.49	21.16	14.47	-13.6	-31.6	-40.9
II (low)	25.48	24.38	21.71	-4.3	-11.0	-14.8
Ratio (II:I)	1.04	1.15	1.50			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	27.52	22.29	-	-19.0	-
II (low)	-	33.32	40.33	-	+17.6	-
Ratio (II:I)	-	1.21	1.81			

*The high SES group is composed of 29 census tracts and the low SES group 24 census tracts in 1950 and in 1970. In 1960, 26 and 27 census tracts constitute the high and low SES groups, respectively.

TABLE 37

NEONATAL MORTALITY RATES BY PERCENT AGE 14 AND OVER WIDOWED OR
DIVORCED: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO,
1950, 1960 and 1970*

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	20.19	16.79	11.27	-16.8	-32.9	-44.2
II (low)	22.49	20.19	17.99	-10.2	-10.9	-20.0
Ratio (II:I)	1.11	1.20	1.60			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	19.08	16.41	10.23	-14.0	-37.7	-46.4
II (low)	20.81	18.11	15.18	-13.0	-16.2	-27.1
Ratio (II:I)	1.09	1.10	1.48			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	20.39	15.77	-	-22.7	-
II (low)	-	25.45	24.20	-	-4.9	-
Ratio (II:I)	-	1.25	1.53			

*The high SES group is composed of 29 census tracts and the low SES group 24 census tracts in 1950 and in 1970. In 1960, 26 and 27 census tracts constitute the high and low SES groups, respectively.

TABLE 38

POSTNEONATAL MORTALITY RATES BY PERCENT AGE 14 AND OVER WIDOWED OR
DIVORCED: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO,
1950, 1960 AND 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	6.17	4.98	4.67	-19.3	-6.2	-24.3
II (low)	5.45	6.69	9.52	+18.5	+29.7	+42.8
Ratio (II:I)	.88	1.34	2.04			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	5.41	4.75	4.24	-12.2	-10.7	-21.6
II (low)	4.67	6.27	6.53	+25.5	+4.0	+28.5
Ratio (II:I)	.86	1.32	1.54			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-27.9%	+36.2%	+9.1%
I (high)	-	7.13	6.52	-	-8.6	-
II (low)	-	7.78	16.13	-	+51.8	-
Ratio (II:I)	-	1.09	2.47			

*The high SES group is composed of 29 census tracts and the low SES group 24 census tracts in 1950 and in 1970. In 1960, 26 and 27 census tracts constitute the high and low SES groups, respectively.

sensitivity of family stability on infant mortality for the entire population. The major factor contributing to this trend was similar to the other variables, that the emergence of the marked inverse socioeconomic status/infant mortality relationship had increased through neonatal mortality.

Housing Status Rankings

Housing status was ranked on two variables: the first was a crowding index--percent of dwelling units with 1.01 or more persons per room; and the second was single housing units--percent of dwelling units that were single housing units.

Tables 39 through 43 present the crowding rankings. Overall this variable seemed most sensitive to infant mortality in 1960 since mortality ratios increased from 1950 to 1960 and declined from 1960 to 1970. Gradients were markedly inverse in 1960 for the total population, but less so for the white population (Table 40), which indicates the crowded conditions of the nonwhite population (Tables 41-43) and their contribution to the overall pattern with some rates nearly double that of the white population.

For the second housing variable--percent of dwelling units that were single housing units (Tables 44-48), the social area differential successively increased from 1950 to 1970 for the total population (Table 44), but decreased from 1950 to 1970 for the white population (Table 45). This indicates that the nonwhite population (Tables 46-48) contributed

TABLE 39

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT OF DWELLING UNITS WITH 1.01 OR MORE PERSONS PER ROOM: TOTAL POPULATION, TOLEDO, OHIO, 1950, 1960 AND 1970*

Infant Deaths						
Social Rank	per 1,000 Live Births			% Change	% Change	% Change
Area	1950	1960	1970	1950-60	1960-70	1950-70
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	25.16 (11)	17.76 (9)	17.75 (14)	-29.4	-0.1	-29.5
II	19.46 (11)	22.74 (18)	18.77 (12)	+14.4	-17.5	-3.5
III	25.68 (16)	26.45 (13)	20.68 (13)	+2.9	-21.8	-19.5
IV (low)	32.84 (15)	27.83 (13)	25.92 (14)	-15.3	-6.9	-21.1
Ratio (IV:I)	1.31	1.57	1.46			

Neonatal Deaths						
Social Rank	per 1,000 Live Births			% Change	% Change	% Change
Area	1950	1960	1970	1950-60	1960-70	1950-70
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	20.97 (11)	14.21 (9)	12.95 (14)	-32.2	-8.9	-38.2
II	16.54 (11)	17.69 (18)	13.68 (12)	+6.5	-22.7	-17.3
III	19.50 (16)	19.89 (13)	12.29 (13)	+2.0	-38.2	-37.0
IV (low)	23.79 (15)	20.49 (13)	17.71 (14)	-13.9	-13.6	-25.6
Ratio (IV:I)	1.13	1.44	1.37			

Postneonatal Deaths						
Social Rank	per 1,000 Live Births			% Change	% Change	% Change
Area	1950	1960	1970	1950-60	1960-70	1950-70
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	4.19 (11)	3.55 (9)	4.80 (14)	-15.3	+26.0	+12.7
II	2.92 (11)	5.05 (18)	5.09 (12)	+42.2	+0.8	+42.6
III	6.18 (16)	6.56 (13)	8.39 (13)	+5.8	+21.8	+26.3
IV (low)	9.05 (15)	7.34 (13)	8.21 (14)	-18.9	+10.6	-9.3
Ratio (IV:I)	2.16	2.07	1.71			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 40

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT OF DWELLING UNITS WITH 1.01 OR MORE PERSONS PER ROOM: WHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	24.97 (11)	16.56 (9)	17.23 (14)	-29.7	-1.9	-31.0
II	19.42 (11)	22.32 (18)	17.13 (12)	+13.0	-23.3	-11.8
III	24.97 (16)	25.88 (13)	16.48 (13)	+3.5	-36.3	-34.0
IV (low)	30.78 (15)	23.73 (13)	18.93 (14)	-22.9	-20.2	-38.5
Ratio (IV:I)	1.23	1.35	1.10			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	20.77 (11)	13.99 (9)	13.05 (14)	-32.6	-6.7	-37.2
II	16.72 (11)	17.09 (18)	12.62 (12)	+2.2	-26.2	-24.3
III	18.88 (16)	19.58 (13)	9.12 (13)	+3.6	-53.4	-51.7
IV (low)	22.43 (15)	17.06 (13)	14.40 (14)	-23.9	-15.6	-35.8
Ratio (IV:I)	1.08	1.22	1.10			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	4.20 (11)	3.57 (9)	4.18 (14)	-15.0	+14.6	-0.5
II	2.70 (11)	5.23 (18)	4.51 (12)	+48.4	-13.8	+40.1
III	6.09 (16)	6.30 (13)	7.36 (13)	+3.3	+14.4	+17.3
IV (low)	8.35 (15)	6.67 (13)	4.53 (14)	-20.1	-32.1	-45.7
Ratio (IV:I)	1.99	1.87	1.08			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 41

INFANT MORTALITY RATES BY PERCENT OF DWELLING UNITS WITH 1.01 OR MORE PERSONS PER ROOM: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 AND 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	22.21	20.84	18.23	-6.2	-12.5	-17.9
II (low)	29.62	27.20	23.23	-8.2	-14.6	-21.6
Ratio (II:I)	1.33	1.31	1.27			
<u>White Population</u>						
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	22.10	20.47	17.19	-7.4	-16.0	-22.2
II (low)	27.87	25.07	17.50	-10.0	-30.2	-37.2
Ratio (II:I)	1.26	1.22	1.02			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	37.04	33.33	-	-10.0	-
II (low)	-	31.44	31.30	-	-0.4	-
Ratio (II:I)	-	.85	.94			

*The high SES group is composed of 22 census tracts and the low SES group 31 census tracts in 1950. In 1960, the high-low SES groups have 27 and 26 census tracts, respectively; and for 1970, the high and low groupings consist of 26 and 27 census tracts, respectively.

TABLE 42

NEONATAL MORTALITY RATES BY PERCENT OF DWELLING UNITS WITH 1.01 OR MORE PERSONS PER ROOM: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 AND 1970*

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	18.67	16.36	13.29	-12.4	-18.8	-28.8
II (low)	21.86	20.21	14.93	-7.5	-26.2	-31.7
Ratio (II:I)	1.17	1.24	1.12			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	18.67	15.88	12.86	-14.9	-19.0	-31.1
II (low)	20.65	18.63	11.32	-9.8	-39.2	-45.2
Ratio (II:I)	1.11	1.17	.88			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	37.04	19.60	-	-47.1	-
II (low)	-	23.37	20.63	-	-11.7	-
Ratio (II:I)	-	.63	1.05			

*The high SES group is composed of 22 census tracts and the low SES group 31 census tracts in 1950. In 1960, the high-low SES groups have 27 and 26 census tracts, respectively; and for 1970, the high and low groupings consist of 26 and 27 census tracts, respectively.

TABLE 43

POSTNEONATAL MORTALITY RATES BY PERCENT OF DWELLING UNITS WITH 1.01 OR MORE PERSONS PER ROOM: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 AND 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	3.54	4.48	4.94	+21.2	+9.3	+28.5
II (low)	7.76	6.99	8.30	-10.0	+15.8	+6.5
Ratio (II:I)	2.20	1.56	1.68			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	3.43	4.59	4.33	+25.1	-5.5	+20.8
II (low)	7.22	6.44	6.18	-10.8	-4.0	-14.4
Ratio (II:I)	2.10	1.41	1.43			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-29.7%	+36.2	+9.1%
I (high)	-	-	13.73	-	-	-
II (low)	-	8.07	11.67	-	+30.8	-
Ratio (II:I)	-	-	.85			

*The high SES group is composed of 22 census tracts and the low SES group 31 census tracts in 1950. In 1960, the high-low SES groups have 27 and 26 census tracts, respectively; and for 1970, the high and low groupings consist of 26 and 27 census tracts, respectively.

TABLE 44

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT SINGLE HOUSING UNITS: TOTAL POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	27.56 (12)	19.25 (12)	16.71 (12)	-30.2	-13.2	-39.4
II	23.08 (14)	22.26 (13)	19.58 (13)	-3.6	-12.0	-15.2
III	26.28 (13)	25.11 (12)	18.89 (13)	-0.6	-27.7	-28.1
IV (low)	29.08 (14)	27.76 (16)	28.40 (15)	-4.5	+2.3	-2.3
Ratio (IV:I)	1.06	1.44	1.70			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	21.60 (12)	15.05 (12)	11.81 (12)	-30.3	-21.5	-45.3
II	17.11 (14)	17.15 (13)	13.86 (13)	+0.2	-19.2	-19.0
III	21.48 (13)	19.53 (12)	12.46 (13)	-9.1	-36.2	-42.0
IV (low)	21.94 (14)	20.86 (16)	18.54 (15)	-4.9	-11.1	-15.5
Ratio (IV:I)	1.02	1.39	1.57			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	5.96 (12)	4.20 (12)	4.90 (12)	-29.5	+14.3	-17.8
II	5.97 (14)	5.11 (13)	5.72 (13)	-14.4	+10.7	-4.2
III	4.80 (13)	6.58 (12)	6.43 (13)	+27.1	-2.3	+25.3
IV (low)	7.14 (14)	6.90 (16)	9.86 (15)	-3.4	+30.0	+27.6
Ratio (IV:I)	1.20	1.64	2.01			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 45

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY PERCENT SINGLE HOUSING UNITS: WHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	27.14 (12)	16.79 (12)	15.99 (12)	-38.1	-4.8	-41.1
II	21.93 (14)	21.64 (13)	15.90 (13)	-1.3	-26.5	-27.5
III	26.02 (13)	25.55 (12)	17.02 (13)	-1.8	-33.4	-34.6
IV (low)	25.39 (14)	25.18 (16)	21.26 (15)	-0.8	-15.6	-16.3
Ratio (IV:I)	.94	1.50	1.33			

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	19.62	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	21.53 (12)	13.09 (12)	11.52 (12)	-39.2	-12.0	-46.5
II	16.72 (14)	16.65 (13)	11.36 (13)	-9.4	-31.8	-32.1
III	21.57 (13)	18.91 (12)	11.18 (13)	-12.3	-40.9	-48.2
IV (low)	19.10 (14)	19.12 (16)	15.57 (15)	+0.1	-18.6	-18.5
Ratio (IV:I)	.89	1.46	1.35			

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	5.61 (12)	3.70 (12)	4.47 (12)	-34.0	+17.2	-20.3
II	5.21 (14)	4.99 (13)	4.54 (13)	-4.2	-9.0	-12.9
III	4.45 (13)	6.65 (12)	5.84 (13)	+33.0	-12.0	+23.8
IV (low)	6.29 (14)	6.06 (16)	5.69 (15)	-3.7	-6.1	-9.5
Ratio (IV:I)	1.12	1.64	1.27			

*Numbers in parentheses are the number of census tracts in each social area.

TABLE 46

INFANT MORTALITY RATES BY PERCENT SINGLE HOUSING UNITS: TOTAL,
WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Infant Deaths per 1,000 Live Births			% Change 1950-60	% Change 1960-70	% Change 1950-70
	1950	1960	1970			
<u>Total Population</u>						
City Total	26.53	24.20	20.96	-8.8%	-13.4%	-21.0%
I (high)	24.93	20.98	18.34	-15.8	-12.6	-26.4
II (low)	27.76	27.04	23.20	-2.6	-14.2	-16.4
Ratio (II:I)	1.11	1.29	1.27			
<u>White Population</u>						
City Total	24.98	22.58	17.40	-9.6%	-22.9%	-30.3%
I (high)	24.14	19.59	15.94	-18.8	-18.6	-34.0
II (low)	25.71	25.36	18.72	-1.4	-26.2	-27.2
Ratio (II:I)	1.07	1.29	1.17			
<u>Nonwhite Population</u>						
City Total	38.14	31.76	32.19	-16.7%	+1.3%	-15.6%
I (high)	-	30.45	29.97	-	-1.6	-
II (low)	-	32.37	33.62	-	+3.7	-
Ratio (II:I)	-	1.06	1.12			

*The high SES group is composed of 26 census tracts and the low SES group 27 census tracts in 1950. In both 1960 and 1970, 25 and 28 census tracts make up the high and low SES groups, respectively.

TABLE 47

NEONATAL MORTALITY RATES BY PERCENT SINGLE HOUSING UNITS: TOTAL,
WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Neonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	20.52	18.44	14.19	-10.1%	-23.0%	-30.8%
I (high)	18.96	16.26	12.98	-14.2	-20.2	-31.5
II (low)	21.72	20.28	15.22	-6.6	-25.0	-30.0
Ratio (II:I)	1.15	1.25	1.17			
<u>White Population</u>						
City Total	19.61	17.19	12.26	-12.4%	-28.7%	-37.5%
I (high)	18.76	15.14	11.43	-19.3	-24.5	-39.1
II (low)	20.35	19.02	12.94	-6.5	-32.0	-36.4
Ratio (II:I)	1.08	1.26	1.13			
<u>Nonwhite Population</u>						
City Total	27.31	24.15	20.27	-11.6%	-16.1%	-25.8%
I (high)	-	23.87	20.47	-	-14.2	-
II (low)	-	24.28	20.53	-	-15.4	-
Ratio (II:I)	-	1.02	1.00			

*The high SES group is composed of 26 census tracts and the low SES group 27 census tracts in 1950. In both 1960 and 1970, 25 and 28 census tracts make up the high and low SES groups, respectively.

TABLE 48

POSTNEONATAL MORTALITY RATES BY PERCENT SINGLE HOUSING UNITS: TOTAL, WHITE AND NONWHITE POPULATION, TOLEDO, OHIO, 1950, 1960 and 1970*

Social Rank Area	Postneonatal Deaths per 1,000 Live Births			% Change		
	1950	1960	1970	1950-60	1960-70	1950-70
<u>Total Population</u>						
City Total	6.01	5.76	6.77	-4.2%	+14.9%	+11.2%
I (high)	5.97	4.72	5.36	-20.9	+11.9	-10.2
II (low)	6.04	6.76	7.98	+10.7	+15.3	+24.3
Ratio (II:I)	1.01	1.43	1.49			
<u>White Population</u>						
City Total	5.36	5.39	5.14	+0.6%	-4.6%	-4.1%
I (high)	5.38	4.45	4.51	-17.3	+1.3	-16.2
II (low)	5.36	6.34	5.78	+15.5	-8.8	+7.3
Ratio (II:I)	.99	1.42	1.28			
<u>Nonwhite Population</u>						
City Total	10.83	7.61	11.92	-29.7%	+36.2%	+9.1%
I (high)	-	6.58	9.50	-	+30.7	-
II (low)	-	8.09	13.09	-	+38.2	-
Ratio (II:I)	-	1.23	1.38			

*The high SES group is composed of 26 census tracts and the low SES group 27 census tracts in 1950. In both 1960 and 1970, 25 and 28 census tracts make up the high and low SES groups, respectively.

to the overall increase in 1970 with high infant mortality rates, and that the neonatal mortality/socioeconomic status relationship was inverse and sensitive.

Both housing indicators appeared to be most sensitive to infant mortality in 1960 which further substantiates the lesser role of housing in the most recent period as an indicator of infant mortality/socioeconomic status differentials.

In sum, the social area analysis exhibited an overall increasing socioeconomic differential especially for the economic and family status variables. Housing status differentials declined from 1960 to 1970 indicating the lesser role of housing conditions in Toledo in the most recent period. The infant mortality/socioeconomic status association was not as marked for the white population as it was for nonwhites, and the overall increasing differential for both whites and nonwhites resulted from the emergence of a pronounced inverse relationship between socioeconomic status and the neonatal component of infant mortality.

Cause of Death Types

This section briefly analyzes cause of death for the infant mortality/socioeconomic status relationship in Toledo for three time periods. Only a two group cause of death (endogeneous and exogeneous) was permitted because of the small number of infant deaths. A more detailed analysis with numerous causes of death would have resulted in unreliable rates and many empty cells. Only one socioeconomic measure, median

family income, was used to differentiate socioeconomic status into two groups (high status and low status) for this cause of death analysis. Since the general trend and pattern of the socioeconomic differential was fairly consistent for all measures, it was felt that only one socioeconomic indicator would suffice for this section of the analysis. The choice of income as the one measure was dictated by the fact, noted above, that this is the most sensitive differentiating variable with respect to infant mortality. There were 26 tracts in the high socioeconomic group and 27 tracts in the low socioeconomic group.

Endogeneous causes of death usually correspond to neonatal mortality (birth-1 month) because these causes are directly attributable to the birth process. Exogeneous causes, on the other hand, generally correspond to postneonatal mortality (1 month through 11 months) and are usually attributable to environmental factors. The following causes of death and the corresponding cause of death codes were included in each broad endogeneous and exogeneous category (World Health Organization, 1957; U.S. DHEW, 1977):

Endogeneous causes

1. congenital malformations (740-759)
2. birth injuries, asphyxia, and infections of the newborn (760-769)
3. other diseases peculiar to early infancy including immaturity/prematurity (770-778)

Exogeneous causes

1. certain gastrointestinal diseases (004, 006-009, 535, 561, 563)
2. influenza and pneumonia (470-474, 480-486)
3. accidents and all other causes (residual)

Table 49 shows infant, neonatal and postneonatal mortality rates in the two broad income groups by cause type for the white population (there were too few cases resulting in empty cells for the nonwhite population). Inverse relationships existed for all mortality and cause types in 1960 and 1970. Endogeneous rates declined from 1950 to 1970 while exogeneous rates increased. The increasing exogeneous rates in the neonatal period for both social areas were particularly striking indicating the increasing importance of environmental factors (exogeneous causes) in the neonatal period.

Table 50 exhibits infant mortality component percentages by cause type for the white population. For total infant mortality, an increasing percent of infant deaths occurred as a result of exogeneous causes, and conversely, a decreasing percent by endogeneous causes. Although the exogeneous cause percent increased in the postneonatal component, the endogeneous cause percent decreased for the neonatal component. Further evidence (Table 51) suggested that this inconsistency was found for the total and white populations. These trends indicate by cause definition that more infant deaths were occurring in the postneonatal period in 1970. However, the percent of white infant deaths occurring in the postneonatal period were 21.6, 23.9, and 29.3 percent in 1950, 1960 and 1970, respectively. The percent of infant deaths occurring in the exogeneous cause type were 20.9, 22.2 and 43.7 percent for the same years. The

TABLE 49

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATES BY INCOME GROUP
AND CAUSE OF DEATH TYPE: WHITE POPULATION, TOLEDO, OHIO, 1950,
1960 AND 1970

	1950	1960	1970
<u>Total Infant Mortality</u>			
Endogeneous			
high	21.1	16.2	8.5
low	18.7	19.0	11.8
Exogeneous			
high	4.5	4.3	6.0
low	6.0	5.8	10.0
<u>Neonatal Mortality</u>			
Endogeneous	18.5	14.7	7.4
high	17.0	17.1	10.0
low			
Exogeneous			
high	2.4	1.2	3.1
low	1.7	1.4	4.9
<u>Postneonatal Mortality</u>			
Endogeneous	2.7	1.5	1.1
high	1.7	1.8	1.8
low			
Exogeneous			
high	2.1	3.2	3.0
low	4.3	4.4	5.1

TABLE 50

INFANT MORTALITY COMPONENT PERCENTAGES BY CAUSE TYPE: WHITE
POPULATION, TOLEDO, OHIO, 1950, 1960 AND 1970

	1950	1960	1970
<u>Total Infant Mortality</u>			
% Endogeneous	79.1	77.8	56.3
% Exogeneous	20.9	22.2	43.7
<u>Neonatal Mortality</u>			
% Endogeneous	89.5	92.5	68.9
% Exogeneous	10.5	7.5	31.1
<u>Postneonatal Mortality</u>			
% Endogeneous	40.9	30.7	26.5
% Exogeneous	59.1	69.3	73.5

TABLE 51

INFANT MORTALITY CAUSE AND PERIOD PERCENT COMPARISONS FOR THE
TOTAL, WHITE AND NONWHITE POPULATION: TOLEDO, OHIO, 1950,
1960 AND 1970

	1950	1960	1970
<u>Total Population</u>			
% by age (birth-1 month)	77.3	76.2	67.7
% by endogeneous causes	77.1	76.3	59.5
% by age (1-12 months)	22.7	23.8	32.3
% by exogeneous causes	22.9	23.7	40.5
<u>White Population</u>			
% by age (birth-1 month)	78.4	76.1	70.7
% by endogeneous causes	79.1	77.8	56.3
% by age (1-12 months)	21.6	23.9	29.3
% by exogeneous causes	20.9	22.2	43.7
<u>Nonwhite Population</u>			
% by age (birth-1 month)	71.7	76.1	63.1
% by endogeneous causes	67.0	71.7	64.7
% by age (1-12 months)	28.3	23.9	36.9
% by exogeneous causes	33.0	28.3	35.3

1950 and 1960 correspondences were similar but the 1970 correspondence was drastically different.

Table 51 further indicated that since exogeneous causes have a higher percentage than the percent in the postneonatal period, exogeneous causes of death were contributing to more than their share of postneonatal deaths. That is, exogeneous causes of death were contributing to deaths in the neonatal period. This occurred for the total and white population but not for the nonwhite population, thus, the white population contributed to the overall pattern in 1970.

In sum, the cause of death analysis suggested that for both the total and white populations, exogeneous (post-neonatal) causes were increasingly contributing to neonatal deaths rather than endogeneous causes. In 1950 and 1960 the correspondence between percent-component mortality and percent-cause type were similar. In 1970 this was not the case and implies a "crossover effect," that is, one type of component mortality was caused in part by the other mortality components cause of death. In this case a portion of neonatal deaths were due to exogeneous causes. This is what likely explains the inverse neonatal pattern and the observed widening of the overall infant mortality/socioeconomic status differential.

Summary and Discussion

This section summarizes and discusses the findings of the social area ranking approach of the study of the relationship

between infant mortality and socioeconomic status. The findings for 1950 indicated that the economic status variables appeared to be strongly related to infant mortality and its components. Education, occupation and income had a steady inverse gradient compared to the family and housing status variables. The ratios of the lowest to the highest social rank area for overall infant, neonatal and postneonatal mortality ratios for the total and white population were notably higher for the economic variables in 1950 (Tables 52 and 53). These variables were also found to be most important in the earlier studies of this same time period; and they confirm Willie and Rothney's (1962) critical income level and Stockwell's (1962a) finding that income was the most sensitive indicator of infant mortality differentials.

The earlier literature review (Chapter II) indicated that during the 1960-78 data period the inverse relationship between infant mortality and socioeconomic status tended to become more pronounced. Kitagawa and Hauser (1973) stated that this trend started in 1964 when infant mortality rates started to decline again after having remained fairly stable for a decade. The findings of the present research generally confirmed this trend. The infant and neonatal mortality ratios increased for virtually all socioeconomic measures from 1950 to 1960. For the same period postneonatal mortality ratios increased for half the variables while the other half decreased slightly. For the white population, postneonatal mortality ratios increased for six of the eight measures.

TABLE 52

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATIOS (SOCIAL AREA IV: SOCIAL AREA I): TOTAL POPULATION, TOLEDO, OHIO, 1950, 1960 AND 1970

Mortality type and independent variables	1950	1960	1970
<u>Infant Mortality</u>			
high school ed.	1.56	1.63	2.27
white collar occ.	1.33	1.70	1.96
median income	1.28	1.84	2.58
unemployment	1.40	1.73	2.65
female labor force	1.01	.87	.59
marital instability	1.10	1.44	2.42
crowding	1.31	1.57	1.46
single housing units	1.06	1.44	1.70
<u>Neonatal Mortality</u>			
high school ed.	1.32	1.50	2.23
white collar occ.	1.16	1.59	1.81
median income	1.15	1.76	2.43
unemployment	1.26	1.67	2.45
female labor force	.96	.76	.62
marital instability	1.09	1.35	2.22
crowding	1.13	1.44	1.37
single housing units	1.02	1.39	1.57
<u>Postneonatal Mortality</u>			
high school ed.	2.88	2.12	2.36
white collar occ.	2.21	2.06	2.30
median income	1.82	2.11	2.86
unemployment	2.03	1.94	3.17
female labor force	1.15	1.25	.52
marital instability	1.13	1.79	2.80
crowding	2.16	2.07	1.71
single housing units	1.20	1.64	2.01

TABLE 53

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATIOS (SOCIAL
AREA IV: SOCIAL AREA I): WHITE POPULATION, TOLEDO, OHIO
1950, 1960 AND 1970

Mortality type and independent variables	1950	1960	1970
<u>Infant Mortality</u>			
high school ed.	1.35	1.48	1.55
white collar occ.	1.17	1.54	1.32
median income	1.12	1.68	1.69
unemployment	1.26	1.77	1.85
female labor force	1.20	1.13	1.02
marital instability	1.00	1.29	1.90
crowding	1.23	1.35	1.10
single housing units	.94	1.50	1.33
<u>Neonatal Mortality</u>			
high school ed.	1.18	1.32	1.68
white collar occ.	1.07	1.27	1.25
median income	1.00	1.54	1.81
unemployment	1.14	1.59	1.91
female labor force	1.16	1.00	.94
marital instability	.99	1.21	1.90
crowding	1.08	1.22	1.10
single housing units	.89	1.46	1.35
<u>Postneonatal Mortality</u>			
high school ed.	2.28	2.09	1.27
white collar occ.	1.70	2.91	1.48
median income	1.62	2.10	1.48
unemployment	1.80	2.41	1.62
female labor force	1.34	1.61	1.25
marital instability	1.05	1.63	1.89
crowding	1.99	1.87	1.08
single housing units	1.12	1.64	1.27

In 1960, as in 1950, the mortality differentials were most pronounced for the economic status variables. Although not as high, the housing status variables seemed to have increased to importance in 1960 for the total and white population.

The literature review of the latter part of this 1960-78 period indicated that the inverse infant mortality/socioeconomic relationship was becoming even more pronounced. The findings of the 1970 social area analysis of this study indicated that this was the case for the total and nonwhite population (Tables 52 and 54). For the white population (Table 53) the relationship became less sensitive because half of the infant and neonatal mortality ratios declined while the other half increased from 1960 to 1970. All but one postneonatal mortality ratio (marital instability) decreased for the white population from 1960 to 1970.

The inverse gradients in 1970 were more pronounced and "inverse like" than in 1960 for total infant and neonatal mortality. Since the overall ratios of the mortality rates in Area IV to those in Area I were nearly all larger in 1970 than in 1960, and larger in 1960 than in 1950, the first, second and third hypotheses were supported; that is, the infant, neonatal and postneonatal/socioeconomic status relationships became increasingly inverse from 1950 to 1970. The major difference was that the type of status has changed somewhat. In 1950, economic status seemed to have dominated, whereas in 1960 the

economic status variables and secondly, the housing status variables seemed to predominate. In 1970, the strongest relationships appeared to characterize family status variables and economic status variables. Family status had the highest mortality ratios in 1970 and the largest 1960-70 increase. The more pronounced overall 1970 relationship was clearly in line with other research of the same or similar data years (Bendor et al., 1971; Brooks 1975a; 1975b; Adamchak et al., 1976; Markides and Barnes, 1977; Stockwell and Laidlaw, 1977; Adamchak and Stockwell, 1978; Stockwell and Adamchak, 1978).

The findings of this research also support the fourth hypothesis that the ratio of the lowest to the highest socioeconomic group would be greater in 1960 than in 1950, and still greater in 1970 than in 1960. These mortality ratios increased for the total population from 1950 to 1970, and for the nonwhite population from 1960 to 1970. The white population, however, deviated slightly from this trend. Although the mortality ratios increased from 1950 to 1960, half of the infant and neonatal mortality ratios declined while the other half increased. All mortality ratios except for marital instability decreased from 1960 to 1970 for white postneonatal mortality.

The final hypothesis for the social area analysis was that the relationship between the lowest social area and all others will become more distinct, while the differences between the other higher areas would tend to become blurred. This hypothesis was only partially supported. The relationship

TABLE 54

INFANT, NEONATAL AND POSTNEONATAL MORTALITY RATIOS (SOCIAL
AREA II: SOCIAL AREA I): NONWHITE POPULATION, TOLEDO, OHIO,
1960 AND 1970

Mortality type and independent variables	1960	1970
<u>Infant Mortality</u>		
high school ed.	1.26	1.52
white collar occ.	1.02	1.91
median income	1.02	1.64
unemployment	1.15	1.31
female labor force	-	-
marital instability	1.21	1.81
crowding	.85	.94
single housing units	1.06	1.12
<u>Noenatal Mortality</u>		
high school ed.	1.22	1.55
white collar occ.	.93	1.84
median income	.97	1.49
unemployment	1.02	1.54
female labor force	-	-
marital instability	1.25	1.53
crowding	.63	1.05
single housing units	1.02	1.00
<u>Postneonatal Mortality</u>		
high school ed.	1.38	1.48
white collar occ.	1.35	2.04
median income	1.24	1.96
unemployment	1.98	1.03
female labor force	-	-
marital instability	1.09	2.47
crowding	-	.85
single housing units	1.23	1.38

between the lowest social area and all others became more distinct for postneonatal mortality but not for total infant mortality or neonatal mortality. Throughout the analysis the rates for Areas II and III were similar. In 1960, there was a difference between Areas I, II and III and Area IV in postneonatal mortality for occupation, income, unemployment and female labor force participation. In 1970, the difference was noticed for education, occupation, income and unemployment for postneonatal mortality; for marital instability for infant and postneonatal mortality; for crowding for infant and neonatal mortality; and, for single housing units for infant, neonatal and postneonatal mortality. The distinction did increase over this 20 year period, but it mainly worked through postneonatal mortality which was quite variable throughout the entire analysis with decreasing and increasing rates over the three time periods.

It was clearly evident from the social area analysis that socioeconomic mortality differentials have increased in Toledo from 1950 to 1970 for the total and nonwhite population. The white population seemed to have deviated slightly from this pattern. Although an increasing socioeconomic mortality differential was detected from 1950 to 1960, from 1960 to 1970 the differential declined somewhat as evidence by the fact that half the mortality ratios increased and the other half decreased. This was further evidenced by the city total postneonatal 1950-70 percent change. It increased 11.2 percent for the total population, but decreased 4.1 percent

for the white population indicating that the overall increase was contributed by the nonwhite population whose rates were one-fourth to one-half larger than white rates. The nonwhite postneonatal rate increased 36.2 percent from 1960 to 1970 and 9.1 percent from 1950 to 1970.

The cause of death analysis also revealed a changing trend for the white population. Exogeneous causes of death were contributing to infant deaths in the neonatal period. Although the white postneonatal rates declined slightly from 1950 to 1970, a "cause-period cross-over effect" was evidenced. This could mean that the lower socioeconomic segment of the white population was experiencing adverse living and unstable family and economic conditions. The exogeneous causes of death in the neonatal period could perhaps indicate that white infants under 1 month of age were expiring from infectious and accidental causes, and this is what probably caused the marked inverse neonatal pattern and the observed widening of the infant mortality/socioeconomic status relationship. There was also an increase in the percent of infant deaths occurring in the postneonatal period in 1970 for both the white and nonwhite populations. This finding could indicate that medical advances have and/or are prolonging the infants' life into the second and subsequent months (e.g., infants that would have normally died in the neonatal period have survived into and died in the postneonatal period). However, adverse social and economic conditions could have simply increased resulting in increased

postneonatal mortality.

As evidenced by the mortality ratios and the social area gradients, the status variables that the differentials were working through seemed to have shifted from one time period to another. In 1950, economic status was primarily responsible; in 1960, it was economic status and housing status; and in 1970, family status and economic status seemed to predominate. These relationships were further examined by means of a correlation analysis in order to measure their strength in terms of explained variance and to determine which variables dominated the relationship in each time period. This is the focus of the next major section.

Correlational Analysis

This second major aspect of this study focused on the infant mortality/socioeconomic status relationship using correlational procedures. Zero-order correlation coefficients are provided in Table 55. A comparison of the three time periods indicates that infant, neonatal and postneonatal mortality have a negative relationship with those measures that are direct indicators of status (e.g., education, occupation, income and single housing units), and a positive relationship with the remaining variables that are inverse indicators of status. Although some correlation coefficients are modest, all but three are in the predicted direction and for the most part statistically significant at the .05 level. Most coefficients become increasingly stronger from 1950 to 1970,

TABLE 55

ZERO-ORDER CORRELATION COEFFICIENTS BETWEEN INFANT, NEONATAL
AND POSTNEONATAL MORTALITY RATES AND SELECTED SOCIOECONOMIC
MEASURES: TOLEDO, OHIO, 1950, 1960 AND 1970

	1950	1960	1970
<u>Infant Mortality</u>			
HS education	-.34	-.34	-.46
white collar occ.	-.29	-.31	-.50
median income	-.27	-.42	-.67
unemployment	.41	.39	.66
female labor force	-.08	.01	.54
marital instability	.17	.35	.60
crowding	.44	.26	.32
single housing units	-.18	-.40	-.40
nonwhite	.24	.26	.66
<u>Neonatal Mortality</u>			
HS education	-.14	-.29	-.43
white collar occ.	-.12	-.23	-.45
median income	-.12	-.34	-.53
unemployment	.26	.35	.52
female labor force	.03	.12	.39
marital instability	.08	.27	.48
crowding	.22	.18	.23
single housing units	-.12	-.32	-.33
nonwhite	.16	.25	.52
<u>Postneonatal Mortality</u>			
HS education	-.47	-.33	-.29
white collar occ.	-.40	-.36	-.33
median income	-.36	-.43	-.53
unemployment	.40	.34	.52
female labor force	-.24	-.24	.47
marital instability	.21	.38	.48
crowding	.53	.34	.29
single housing units	-.18	-.41	-.30
nonwhite	.22	.19	.52

Coefficients greater than .21 are statistically significant
at the .05 level.

thus supporting the hypothesis of a widening socioeconomic morality differential. The only variable that deviates from the predicted direction was female labor force participation. A negative association was predicted between infant mortality and its components and female labor force participation, but such association was found only for total infant mortality in 1950 (not significant) and for postneonatal mortality in 1950 and 1960 (significant at the .05 level). In 1970, however, this variable was significantly correlated in a high positive direction with all three infant mortality rates. Thus, contrary to expectations, it appears that this variable has emerged as a negative index of status; the lower the status, the higher the percentage of females who are in the labor force.

With the exception of the crowding variable, the relationship between socioeconomic status and mortality increased for both total and neonatal mortality between 1950 and 1970, particularly for neonatal mortality. For postneonatal mortality the predicted associations became stronger during this period for all but three variables (education, occupation and crowding). The most salient conclusion to be drawn from this phase of the analysis then, despite the few exceptions noted, is that the general decline in infant mortality in recent years has not been accompanied by the expected narrowing of the socioeconomic differential. On the contrary, the relationship has become more pronounced over the years; and the major contributing factor to this

widening differential has been the emergence of a very pronounced inverse relationship between the several socioeconomic variables and the neonatal death rate.

Tables 56, 57 and 58 provide squared zero-order, squared semipartial and squared partial correlation coefficients between infant, neonatal and postneonatal mortality and the eight socioeconomic measures for the three time periods. Table 56 indicated that in 1950 high school education accounted for 11.4 percent of the variance in infant mortality ($r^2 = .114$). When the effect of race is removed from the relationship education accounts for 7.3 percent of variance ($pr^2 = .073$); and when the effect of race on education alone is removed this variable explains nearly 7 percent of the variance in infant mortality ($sr^2 = .069$). Similarly, when the effect of race was removed from the independent variables unemployment and crowding they accounted for 11.8 and 14.6 percent of the variance in infant mortality. These three were the only squared semipartials that were statistically significant in 1950.

In 1960, the squared semipartials were statistically significant for high school education, median income, unemployment, marital instability, and single housing units. Education and unemployment declined slightly while crowding declined from uniquely explaining 14.6 to 1 percent of the variance in infant mortality. In 1970, housing status variables explained very little while the economic and family status

TABLE 56

SQUARED ZERO-ORDER, SQUARED SEMIPARTIAL, AND SQUARED PARTIAL
CORRELATION COEFFICIENTS FOR INFANT MORTALITY WITH SOCIO-
ECONOMIC STATUS VARIABLES: TOLEDO, OHIO, 1950, 1960 AND 1970
(NONWHITE CONTROL FOR sr^2 AND pr^2)

SES variables	r^2			sr^2			pr^2		
	1950	1960	1970	1950	1960	1970	1950	1960	1970
HS education	.114*	.118*	.214***	.069*	.070*	.052*	.073*	.075*	.092*
white collar	.083*	.094*	.249***	.041	.040	.060*	.044	.042	.105*
med. income	.071	.180**	.445***	.027	.112**	.123***	.028	.120**	.215***
unemployment	.170**	.154**	.433***	.118**	.087*	.088**	.125**	.093*	.155**
female labor	.007	.001	.291***	.020	.015	.009	.021	.016	.015
marital inst.	.027	.121*	.364***	.011	.079*	.132***	.012	.085*	.231***
crowding	.190**	.069	.103	.146***	.011	.001	.154***	.012	.002
single housing	.034	.157**	.157**	.017	.120**	.030	.018	.130**	.053

1950 $R^2_{Y \cdot 1 \dots 9} = .245$ $RY \cdot 1 \dots 9 = .495$

1960 $R^2_{Y \cdot 1 \dots 9} = .340$ $RY \cdot 1 \dots 9 = .583$

1970 $R^2_{Y \cdot 1 \dots 9} = .657$ $RY \cdot 1 \dots 9 = .811$

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

TABLE 57

SQUARED ZERO ORDER, SQUARED SEMIPARTIAL, AND SQUARED PARTIAL
CORRELATION COEFFICIENTS FOR NEONATAL MORTALITY WITH SOCIO-
ECONOMIC STATUS VARIABLES: TOLEDO, OHIO, 1950, 1960 AND 1970
(NONWHITE CONTROL FOR sr^2 AND pr^2)

variables	r^2			sr^2			pr^2		
	1950	1960	1970	1950	1960	1970	1950	1970	1970
HS education	.020	.084*	.184**	.007	.044	.062*	.007	.047	.085*
white collar	.014	.051	.203***	.003	.013	.065*	.003	.013	.089*
med. income	.014	.118*	.279***	.001	.062*	.078*	.002	.066	.106*
unemployment	.070	.120*	.274***	.046	.057*	.057*	.047	.061	.078*
female labor	.001	.015	.154**	.001	.001	.001	.001	.001	.001
marital inst.	.006	.073	.229***	.001	.042	.084*	.002	.045	.115*
crowding	.049	.032	.052	.024	.001	.003	.025	.001	.004
single housing	.014	.100*	.106*	.007	.072*	.023	.007	.078*	.031

$$1950 \quad R^2 Y \cdot 1 \dots 9 = .135 \quad RY \cdot 1 \dots 9 = .367$$

$$1960 \quad R^2 Y \cdot 1 \dots 9 = .297 \quad RY \cdot 1 \dots 9 = .545$$

$$1970 \quad R^2 Y \cdot 1 \dots 9 = .418 \quad RY \cdot 1 \dots 9 = .647$$

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

TABLE 58

SQUARED ZERO ORDER, SQUARED SEMIPARTIAL, AND SQUARED PARTIAL
CORRELATION COEFFICIENTS FOR POSTNEONATAL MORTALITY WITH SOCIO-
ECONOMIC STATUS VARIABLES: TOLEDO, OHIO, 1950, 1960 AND 1970
(NONWHITE CONTROL FOR sr^2 AND pr^2)

variables	r^2			sr^2			pr^2		
	1950	1960	1970	1950	1960	1970	1950	1960	1970
HS education	.223***	.109*	.085*	.177**	.078*	.009	.086**	.081*	.013
white collar	.162**	.128**	.108*	.117*	.092*	.014	.123*	.096*	.019
med. income	.127**	.186**	.281***	.081*	.152**	.076*	.085*	.158**	.106*
unemployment	.161**	.116*	.272***	.119**	.088*	.054*	.125**	.092*	.075*
female labor	.057	.058	.222***	.088*	.128**	.018	.092*	.132**	.024
marital inst.	.045	.142**	.228***	.026	.112*	.082*	.028	.116*	.113*
crowding	.285***	.115*	.083*	.291***	.085*	.001	.301***	.088*	.001
single housing	.032	.171**	.089*	.017	.145**	.014	.018	.151**	.020

1950 $R^2 Y \cdot 1 \dots 0 = .393$ $RY \cdot 1 \dots 9 = .627$

1960 $R^2 Y \cdot 1 \dots 9 = .439$ $RY \cdot 1 \dots 9 = .662$

1970 $R^2 Y \cdot 1 \dots 9 = .492$ $RY \cdot 1 \dots 9 = .701$

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

variables clearly explained most. In fact, marital instability uniquely explained 13.2 percent of the variance in infant mortality in 1970 ($sr^2 = .132$), and was significant at the .001 level. In 1950 it was difficult to identify the status type that had the greatest explanatory power although crowding had the largest squared semipartial ($sr^2 = .146$; significant at the .001 level). In 1960, the largest sr^2 's were dispersed throughout the three status types, and in 1970 both family and economic status were strong predictors. It was clearly evident from Table 56 that socioeconomic status accounted for more variance in infant mortality in 1960 than in 1950, and more in 1970 than in 1960. This supports the sixth and final hypothesis.

The bottom of Table 56 shows the multiple correlation (R) and its square (explained variance- R^2) for all nine variables (eight independent variables and the control variable). R^2 's for 1950, 1960 and 1970 explained 24.5, 34.0 and 65.7 percent of the variance in infant mortality, respectively. The large increase from 1960 to 1970 indicates that socioeconomic status variables became more sensitive to infant mortality during that decade.

Table 57 shows that in 1950 and 1960 no clear cut status type pattern existed for neonatal mortality. In 1950 unemployment uniquely explained the largest amount of the variance (4.6 percent) in neonatal mortality, but it was not statistically significant. In 1960 single housing units

explained 7.2 percent ($sr^2 = .072$, significant at the .05 level). Income and unemployment also reached the .05 level of significance in 1960. In 1970 for neonatal mortality, the same five variables were significant as in total infant mortality. The family status variable, marital instability, uniquely explained 8.4 percent of the variance, the highest in 1970. For each successive period, socioeconomic status had become more sensitive to neonatal mortality. This was also evidenced in the R^2 's. In 1950, 1960 and 1970 all variables taken together explained 13.5, 29.7 and 41.8 percent of the variance in neonatal mortality.

Postneonatal mortality has traditionally been very sensitive to socioeconomic status as shown in Table 58. In 1950, all sr^2 's except for marital instability and single housing units were statistically significant. Education and crowding uniquely explained 17.7 and 29.1 percent of the variance in postneonatal mortality, respectively. In 1960, all sr^2 's were significant, with income, female labor force participation and single housing units uniquely explaining the most variance in postneonatal mortality (sr^2 's = .152, .128 and .145, respectively).

From 1960 to 1970 all sr^2 's declined indicating that the individual uniqueness of each independent variable explained less variance in postneonatal mortality. However, the R^2 's of all variables considered increased from 39.3 percent in 1950, to 43.9 percent in 1960, and finally, to 49.2 percent

in 1970, thus explaining nearly half of the variance in post-neonatal mortality at the most recent date. The increments in the R^2 's for postneonatal mortality were not as great as infant or neonatal mortality, however, indicating that the importance of this components' contribution to the infant mortality/socioeconomic status relationship had become relatively less important.

In order to view the relationship between total infant mortality and socioeconomic status longitudinally, Figure 4 graphically shows sr^2 's. In 1950 crowding (housing variable) and unemployment (family variable) contribute most to infant mortality. In 1960, single housing units (housing variable) and income (economic variable) uniquely explained more variance in infant mortality; and in 1970, marital instability (family variable) and income dominated. Marital instability (family) increased most from 1950 to 1970 and crowding (housing) had the largest decrease for the same period.

Table 59 presents squared semipartial correlation coefficients between infant, neonatal and postneonatal mortality and economic, family and housing status variable sets for the three time periods. In this table it can be seen that for total infant mortality in 1950 economic status uniquely accounted for only 1.7 percent of the variance in infant mortality when family status, housing status and percent nonwhite were partialled out of economic status only [$R^2_{Y(E \cdot FHB)} = .017$]. In 1950 for total infant mortality,

FIGURE 4

SQUARED SEMIPARTIAL CORRELATION COEFFICIENTS BETWEEN INFANT MORTALITY RATES AND SOCIOECONOMIC STATUS VARIABLES: TOLEDO OHIO, 1950, 1960 AND 1970 (NONWHITE CONTROL)

TABLE 59

SQUARED SEMIPARTIAL CORRELATION COEFFICIENTS BETWEEN INFANT, NEONATAL AND POST-NEONATAL MORTALITY AND ECONOMIC (E), FAMILY (F) AND HOUSING STATUS (H): TOLEDO OHIO, 1950, 1960 AND 1970 (NONWHITE (B) CONTROLLED)

Status Types	Infant Mortality			Neonatal Mortality			Postneonatal Mortality		
	1950	1960	1970	1950	1960	1970	1950	1960	1970
<u>Economic (E)</u>									
$R^2_{Y(E \cdot B)}$	.028	.113*	.123**	.002	.062	.078*	.086*	.153**	.076*
$R^2_{Y(E \cdot FB)}$	.017	.076*	.014	.002	.016	.014	.142**	.234***	.005
$R^2_{Y(E \cdot EB)}$	.023	.018	.095**	.001	.006	.055*	.115*	.040	.067*
$R^2_{Y(E \cdot FHB)}$	.017	.042	.029	.003	.007	.021	.143**	.146**	.016
<u>Family (F)</u>									
$R^2_{Y(F \cdot B)}$	.012	.044	.158***	.010	.048	.086*	.002	.013	.118**
$R^2_{Y(F \cdot EB)}$	.001	.007	.050*	.011	.002	.021	.059	.093*	.047
$R^2_{Y(F \cdot HB)}$	.007	.006	.143***	.010	.001	.065*	.001	.058	.127**
$R^2_{Y(F \cdot EHB)}$	.001	.030	.076**	.013	.001	.031	.028	.164***	.076*
<u>Housing (H)</u>									
$R^2_{Y(H \cdot B)}$	.007	.116**	.030	.004	.075*	.024	.003	.124**	.014
$R^2_{Y(H \cdot EB)}$	.002	.021	.003	.003	.019	.001	.033	.011	.005
$R^2_{Y(H \cdot FB)}$	.002	.078*	.015	.004	.027	.003	.001	.170**	.023
$R^2_{Y(H \cdot EFB)}$	.001	.044	.030	.004	.018	.010	.002	.082*	.034
	$R^2_{Y \cdot EFHB}$	$RY \cdot EFHB$		$R^2_{Y \cdot EFHB}$	$RY \cdot EFHB$		$R^2_{Y \cdot EFHB}$	$RY \cdot EFHB$	
1950	.086	.293		.042	.204		.193	.440	
1960	.233	.483		.145	.381		.364	.603	
1970	.632	.795		.377	.614		.431	.657	

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

economic status seemed to have the greatest explanatory power, although no relationship set was statistically significant. In 1960, both housing and economic status had significant associations, with housing status having slightly larger explained variances [$R^2_{Y(H \cdot B)} = .116$], $p < .01$; [$R^2_{Y(H \cdot FB)} = .078$], $p < .05$. However, in 1970 family status stands out as the dominant set with large explained variances and with each relationship reaching a level of statistical significance.

Neonatal mortality in both 1950 and 1960 seemed unresponsive to socioeconomic status which coincides with Willie's (1959) and Stockwell's (1962a) assertions. However, in 1970 both the economic status and family status sr^2 's reach statistical significance and indicate that neonatal mortality has become sensitive to socioeconomic status.

In 1950, economic status dominated postneonatal mortality with the largest explained variance coming when family status, housing status and percent nonwhite are partialled out of economic status: [$R^2_{Y(E \cdot FHB)} = .143$], $p < .01$. In 1960 all three status sets shared in explaining postneonatal mortality, but in 1970 family status again stood out as the dominant explanatory set.

The explained variance (R^2) and the multiple correlation (R) were calculated and are shown at the bottom of Table 59. Explained variance for infant, neonatal and postneonatal mortality successively increased from 1950 to 1970 where for total infant mortality the three status variable sets and

the control variable explained 63.2 percent of the variance as compared to 23.3 percent in 1960, and only 8.6 percent in 1950. The R^2 's for the variables taken singly (Tables 56, 57 and 58) were slightly larger than the R^2 's for the variable sets (Table 59). For example, the R^2 for total infant mortality for the variables taken singly was .657 while for the variable sets it was .632. However, both single variables and variable sets distinctly point out that infant mortality became increasingly sensitive to socioeconomic status from 1950 to 1970, and that in 1970 neonatal mortality was almost as sensitive to socioeconomic status as postneonatal mortality ($R^2 = .377$ and $.431$ for variable sets and $R^2 = .418$ and $.492$ for single variables for neonatal and postneonatal mortality, respectively).

Figures 5, 6 and 7 graphically show sr^2 's for each of the three status types controlling on the other two status types and the control variable for infant, neonatal and postneonatal mortality, respectively. Figure 5 (infant mortality) shows that the dominant set for 1950 was economic status. In 1960, first, housing and second, economic status dominated, but these declined in 1970 while family status increased sharply. The trend for neonatal mortality (Figure 6) shows that family status in 1950, housing status in 1960 and family status in 1970 explained most of the variance. Only housing status declined from 1960 to 1970.

All three status types increased from 1950 to 1960 and declined from 1960 to 1970 for postneonatal mortality

FIGURE 5

SQUARED SEMIPARTIAL CORRELATION COEFFICIENTS BETWEEN INFANT MORTALITY RATES AND ECONOMIC (E), FAMILY (F) AND HOUSING (H) STATUS VARIABLE SETS: TOLEDO, OHIO, 1950, 1960 and 1970 (NONWHITE (B) CONTROL AND EACH SET CONTROLLING ON ALL OTHERS)

FIGURE 6

SQUARED SEMIPARTIAL CORRELATION COEFFICIENTS BETWEEN NEONATAL MORTALITY RATES AND ECONOMIC (E), FAMILY (F) AND HOUSING (H) STATUS VARIABLE SETS: TOLEDO, OHIO, 1950, 1960 and 1970 (NONWHITE (B) CONTROL AND EACH SET CONTROLLING ON ALL OTHERS)

FIGURE 7

SQUARED SEMIPARTIAL CORRELATION COEFFICIENTS BETWEEN POST-NEONATAL MORTALITY RATES AND ECONOMIC (E), FAMILY (F) AND HOUSING (H) STATUS VARIABLE SETS: TOLEDO, OHIO, 1950, 1960 AND 1970 (NONWHITE (B) CONTROL AND EACH SET CONTROLLING ON ALL OTHERS)

(Figure 7). Economic status dominated in 1950, and family status explained more variance in 1960 and 1970 than economic status or housing status.

The declining status set types and single variables for postneonatal mortality from 1960 to 1970 could very well indicate that this type of mortality is becoming less sensitive to socioeconomic status. However, it could have reached a saturation point. This is evidenced by the slight increase in R^2 for postneonatal mortality. In both variable sets and single variables for neonatal mortality the family and economic sets and variables increased from 1960 to 1970 indicating that the increasing sensitivity of infant mortality and socioeconomic status is working through neonatal mortality rather than postneonatal mortality in the most recent period.

Table 60 compares variable sets and single variables for the three mortality types and the three time periods. For total infant mortality in 1950, the comparisons did not coincide (e.g., the dominating single variable was not part of the dominating set). Economic status dominated in the variable sets and crowding (a housing variable) dominated in the single variable scheme. In 1960 and 1970 the comparisons were similar. Housing and economic status in the variable set and single housing units (housing) and income (economic) in the single variable scheme dominated the relationship. Similarly, the convergence in 1970 was family status and marital instability (family status) for variable sets and single variables,

TABLE 60

DOMINATING VARIABLE SETS AND SINGLE VARIABLES FOR INFANT, NEO-
NATAL AND POSTNEONATAL MORTALITY: TOLEDO, OHIO, 1950, 1960
AND 1970

Mortality type and year	Variable Sets	Single Variables (Variable Sets)
<u>Total Infant Mortality</u>		
1950	Economic	Crowding (Housing)
1960	Housing (Economic)	Single housing (Housing), Income (Economic)
1970	Family	Marital instability (Family), Income (Economic)
<u>Neonatal Mortality</u>		
1950	Family	Unemployment (Family)
1960	Housing	Single housing (Housing) Income (Economic)
1970	Family	Marital instability (Family), Income (Economic)
<u>Postneonatal Mortality</u>		
1950	Economic	Crowding (Housing)
1960	Family (Economic)	Income (Economic), Single housing (Housing)
1970	Family	Marital instability (Family), Income (Economic)

respectively. All neonatal comparisons were similar and for postneonatal mortality the only convergence came in 1970 (family status). In 1950 and 1960 for postneonatal mortality, the comparisons were disparate.

In 1970, for all three mortality types the variable set that explained the most variance was family status and for the single variables marital instability (family variable) dominated with income (economic variable) explaining the next highest amount. Since family type variables, specifically marital instability, emerged as the dominant infant mortality explanatory variable with income placing second in most cases, it appeared in 1970 that the differences in infant mortality were working through the amount of degree of family disruption. In 1960, it appeared that infant mortality differentials worked through housing variables, and in 1950 one dominant type did not emerge which further substantiates those assertions by Willie, Stockwell and others that infant mortality was at that time not very sensitive to differences in socioeconomic status. However, in 1960 and more so in 1970, clear cut patterns emerge which support the sixth hypothesis, increasing the explained variance of dominant variables and variable sets for all three mortality measures.

Summary and Discussion

This section summarizes and discusses the findings of the correlational analysis. First, the correlational analysis set out to determine if infant mortality and its

components had become more sensitive to socioeconomic status over the three time periods as measured by single variables and status variable sets. Secondly, it sought to identify the variables and variable sets that contributed most to explained variance in total infant, neonatal and postneonatal mortality. Both goals were accomplished.

Explained variance (R^2) for the single variables and variable sets increased from 1950 to 1970 where neonatal mortality converged with postneonatal mortality. In 1970, the R^2 's for single variables and variable sets for neonatal and postneonatal mortality were .418 and .492, and .377 and .431, respectively. In 1950, R^2 for postneonatal mortality was about three times that of neonatal mortality (.393 and .135, respectively) in the single variable analysis; and nearly five times in the variable set analysis (.193 and .042, respectively). In 1960, postneonatal mortality was about double (in R^2 's) that of neonatal mortality, and in 1970 they were nearly equal (postneonatal was slightly higher). This clearly indicates that neonatal mortality has become more sensitive to differences in socioeconomic status; and nearly as sensitive as postneonatal mortality as indicated by the total R^2 's and by the squared semipartial correlation coefficients and their levels of significance.

The variables and variable sets that dominated each time period became more distinct from 1950 to 1970. In 1950 for total infant mortality, economic status dominated in the

variable set category and crowding (housing variable) dominated in the single variable category. However, postneonatal mortality contributed most to this overall (total infant mortality) pattern since it had the same set and variable. Neonatal mortality differed from both in 1950 (see Table 60).

In 1960, the housing status set dominated with economic status placing second for total infant mortality. In the single variable case single housing units (housing) and, second, income (economic) dominated yielding a set-variable correspondence. Both neonatal and postneonatal mortality seemed to contribute to the total infant mortality pattern. Neonatal mortality had almost an exact correspondence to total infant mortality except that economic status did not come forth in the variable set (see Table 60). Neonatal and postneonatal mortality in the single variable category had the same two variables dominate except they were reversed in importance. For the variable set, family status dominated with economic status second, which was inconsistent with neonatal and total infant mortality.

In 1970, there was a perfect correspondence for total infant, neonatal and postneonatal mortality for the variable set and single variables. The dominant variable set for all three mortality types was family status with no other set placing second since both declined from 1960 to 1970 (see Figure 5). The single variable that dominated first was marital instability (family status) and placing second (the

only other variable to steadily increase from 1950 to 1970) was income (economic status). These variables placed in this order in 1970 for all three mortality types (see Table 60).

Therefore, the sensitivity of infant mortality to socioeconomic status was working through family status in 1970. Specifically, marital instability appeared to display the largest sr^2 's in 1970 with large significant zero-order correlations in the hypothesized direction (see Table 55).

It is clear that marital disruption, which has become so prevalent in American society, has a significant impact on this sensitive indicator of the social and economic well-being of our population; that is, on the infant mortality rate. However, marital disruption is not the only determinant of the infant mortality/socioeconomic status relationship. The single variable case indicated that income was nearly as important as marital instability, however marital instability had the greatest 1950-70 increase and in 1970, it overtook income in importance. The underlying "cause" of the relationship (as indicated by the importance of income) could very well be embedded in income differentiation; however, the sensitivity of this differentiation is being manipulated through family status variables, specifically through marital instability.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of the present research was to investigate the dynamics of the relationship between infant mortality and socioeconomic status. To this end, independent variables were analyzed using both a social area ranking approach, and a correlational approach. The dynamics of socioeconomic differentials in infant mortality were analyzed in the former, and the overall impact of diverse socioeconomic variables on infant mortality was investigated in the latter approach.

Review of Hypotheses

In an attempt to systematize this research, six hypotheses were utilized to test the infant mortality/socioeconomic status relationship. The research findings related to these hypotheses are discussed in this section.

H₁: The total infant mortality/socioeconomic status relationship will become increasingly inverse from 1950 to 1960, and from 1960 to 1970.

The data period literature review suggested that the total infant mortality/socioeconomic status relationship was not very pronounced in 1950 but would become increasingly stronger in 1960 and 1970. The research findings supported this hypothesis for the total population from 1950 to 1970;

for the nonwhite population from 1960 to 1970 (the only comparison years); and, for the white population from 1950 to 1960. The white mortality ratios from 1960 to 1970 declined for half of the socioeconomic measures and increased for the other half. This indicates that the relationship among whites could be stabilizing; that is, white socioeconomic differentials are narrowing. This hypothesis was also supported by the correlation analysis since zero-order correlation coefficients increased from 1950 to 1960, and from 1960 to 1970 for the total population. In the social area rankings, gradients were more "inverse like" in 1970 than in the other time periods.

H₂: Because of the growing body of evidence that neonatal mortality varies with socioeconomic factors, it was hypothesized that neonatal mortality would become increasingly inversely related to socioeconomic status from 1950 to 1960, and from 1960 to 1970.

The findings supported this hypothesis for the total population from 1950 to 1970; the nonwhite population from 1960 to 1970 (the only comparison years); and for the white population from 1950 to 1960. As with total infant mortality, half of the white neonatal mortality ratios declined while the other half increased from 1960 to 1970, once again indicating that white socioeconomic differentials have narrowed. The same socioeconomic measures declined as in total infant mortality--white collar occupation, female labor force participation, crowding, and single housing units; and gradients

were more "inverse like" in 1970 than in the other time periods. All zero-order correlations increased in the hypothesized direction from 1950 to 1970.

H₃: Because postneonatal mortality has always been more sensitive to socioeconomic factors, it was hypothesized that postneonatal mortality will become increasingly inversely related to socioeconomic status from 1950 to 1960, and from 1960 to 1970.

Only the nonwhite findings supported this hypothesis. For the total population half of the mortality ratios declined from 1950 to 1960, and six of the eight ratios increased from 1960 to 1970 indicating an erratic pattern. For the white population six of the eight ratios increased from 1950 to 1960 and all but one decreased from 1960 to 1970. The one that increased most markedly over the 20 year period was marital instability. The postneonatal findings indicate that socioeconomic differentials have narrowed for whites but that the nonwhite differentials had widened. Unlike total infant and neonatal mortality rates, postneonatal rates increased from 1950 to 1970 for the total population. This overall increase of 11.2 percent came through the nonwhite population (+9.1 percent) since the white populations postneonatal rate declined 4.1 percent. Also, unlike total infant and neonatal mortality, postneonatal gradients were more "inverse like" in 1960 than in 1950 or 1970. The correlation analysis was consistent with the social area analysis since zero-order correlation coefficients

had an inconsistent increasing/decreasing pattern.

H₄: In the social area analysis it was hypothesized that the ratio of the lowest to the highest socioeconomic group will be greater in 1960 than in 1950, and greater in 1970 than in 1960.

The findings of this hypothesis were related to and discussed in hypotheses 1, 2 and 3. This hypothesis was supported for total infant and neonatal mortality for the total population, and for all three mortality measures for the non-white population. Postneonatal mortality for the total population and all three mortality measures for the white population did not conform to the hypothesized direction. Half of the postneonatal mortality ratios for the total population declined from 1950 to 1960, and six of eight ratios increased from 1960 to 1970. For the white population, half of the ratios declined from 1960 to 1970 for total infant and neonatal mortality, and all ratios except for marital instability decreased from 1960 to 1970 for postneonatal mortality. This indicates that white socioeconomic differentials were beginning to narrow while the nonwhite and total population's differentials are still pronounced and in most cases widening.

H₅: In the social area analysis it was hypothesized that the relationship between the lowest socioeconomic area and all other areas will become more distinct; that is, the relationship between the lowest area and all other areas will be greater in 1960 than in 1950, and still greater in 1970

than in 1960.

This hypothesis was only partially supported. The relationship between the lowest social area and all others became more distinct from 1950 to 1970 for postneonatal mortality for the total population. Total infant and neonatal mortality for the total population did not conform to the hypothesis. The social area differences for the white population were minimal, thus, a pattern did not emerge between the lowest area and the other areas. Only one variable conformed to the hypothesized direction for the white population, that was, marital instability.

H₆: In the correlational analysis it was hypothesized that socioeconomic variables will explain more variance in infant, neonatal and postneonatal mortality in 1960 than in 1950, and more variance in 1970 than in 1960.

The research findings confirmed this hypothesis. For total infant, neonatal and postneonatal mortality for single variables and for variable sets taken together more explained variance was recorded for each successive time period indicating that socioeconomic status had become more sensitive to infant mortality and its components. In fact, neonatal mortality explained nearly as much variance as postneonatal mortality in 1970. The convergence of these mortality components was far greater than in 1950 or 1960 indicating the increasing sensitivity of neonatal mortality to socioeconomic differences.

Implications

One of the purposes of this research and one of the goals of the analyses was to identify the socioeconomic mechanism(s) which operated on infant mortality and its components for each time period. Although the total infant and neonatal mortality rates declined from 1950 to 1970 in Toledo for the total and nonwhite population, and all mortality component rates declined for the white population, it was easily discernible that the increasing postneonatal rate for the total population was primarily operating through the nonwhite population. It was also discernible that socioeconomic mortality differentials as evidenced by mortality ratios successively widened from 1950 to 1970 for the total and nonwhite population. For the white population, socioeconomic mortality differentials widened from 1950 to 1960, but narrowed from 1960 to 1970.

In the cause of death analysis both cause groups, race and mortality type, displayed an inverse socioeconomic relationship in 1960 and 1970. In 1950, the two socioeconomic group scheme yielded a positive relationship, which once again supports the assertions by Willie and Stockwell that socioeconomic status was not that sensitive with infant mortality at least in 1950. The major findings of the cause of death analysis were the "cross-over effect," and the changing percentage of infant deaths in each mortality component. That is, in 1970 postneonatal causes (exogeneous) were contributing to neonatal deaths, perhaps indicating that the population

of Toledo has experienced adverse social and economic conditions where infants in the neonatal period were expiring from infectious and accidental causes. Also interacting is the fact that a higher percentage of infant deaths were occurring in the postneonatal period in 1970 than in 1950 or 1960. This could simply indicate that declining social and economic conditions increased the percent in the postneonatal component, or that a more complex mechanism is working as advances in medicine are prolonging the life of the infant. Infants that would have normally died in the first month of life (neonatal period) may have survived into the second and subsequent months, thus increasing the postneonatal percentage component.

The above findings do not indicate the socioeconomic mechanisms that were contributing to this relationship for each of the three time periods. In order to accomplish this goal the correlational analysis was undertaken. Although all socioeconomic variables and variable sets taken together increasingly explained more variance in infant mortality and its components from 1950 to 1970, the variables and variable sets taken singly indicate the type of socioeconomic status that is contributing most to infant mortality variations at each time period.

Using squared semipartial correlation coefficients between single variables, variable sets and total infant mortality as well as its separate components identifies the socioeconomic status influence on the type of mortality.

From 1950 to 1970 total infant, neonatal and postneonatal mortality converge into a consistent socioeconomic pattern. In 1950 there was a discrepancy among infant mortality components and variable sets and single variables. Economic status came forth as the dominant variable set and crowding (housing variable) as the dominant single variable for total infant mortality in 1950. For neonatal mortality, family status and unemployment (family variable) dominated the set-variable scheme, respectively; and economic status and crowding (housing variable) emerged as influencing postneonatal mortality. Since the same set-variable emerged for both postneonatal and total infant mortality it can be concluded that in 1950 postneonatal mortality was contributing far more to the total infant mortality/socioeconomic status relationship than neonatal mortality, as was illustrated by the total R^2 's in 1950. This conclusion also supports those studies based on 1950 data which stated that the socioeconomic relationship characterized only postneonatal mortality (see Table 60).

In 1960, first housing status and second economic status were the dominant variables sets, and single housing units (housing status) and income (economic status) emerged as the most sensitive predictors in the single variable scheme for total infant mortality. The same set and variables came forth for neonatal mortality in 1960, and for postneonatal mortality the same single variables (although reversed) and family status and economic status emerged in the set scheme.

This indicates that although not perfectly consistent, both neonatal and postneonatal mortality were beginning to coincide in explaining the infant mortality/socioeconomic status relationship. This convergence was also observed in the total R^2 's, which indicated that neonatal mortality was gaining in explained variance.

In 1970, family status was the variable set that dominated the relationship for all three mortality measures, and marital instability (family status) and income (economic status) emerged for all three mortality rates in the single variable scheme. This convergence was also acknowledged in 1970 with the postneonatal total R^2 being only modestly higher than the R^2 for neonatal mortality instead of more than three times as large in 1950. This suggests that in 1970, family status and specifically marital instability was the most sensitive indicator of both neonatal and postneonatal mortality, and thus of total infant mortality. Since income (economic status) emerged second to marital instability in 1970, it appears that adverse economic conditions are being manipulated through the factors that give rise to marital disruption (widowhood and divorce). The fact that 38 percent of first marriages end in divorce in the United States, and that the 1970 divorce rate was equal to the high post-World War II rate, helps to further substantiate this important phenomenon that is affecting this increasingly sensitive measure of the social and economic conditions of our population, that is, the infant

mortality rate.

Future Research

The findings of this research generally confirmed the studies cited in the literature review. For the three time periods a different type of socioeconomic status was influencing infant mortality. Improvements in education, and improvements in housing from 1950 to 1970 confirm the lesser role these factors are playing in infant mortality. As new social problems emerge, it appears that they quickly affect sensitive indicators of well-being such as the infant mortality rate. In 1970, marital instability emerged as the over-riding sensitive indicator affecting infant mortality. Future infant mortality research should concentrate on the family type variables in order to better understand the dynamics of this seemingly sensitive indicator. Longitudinal studies are essential not only to confirm or refute past assertions, but to place the infant mortality/socioeconomic status relationship into a time framework in order to enhance theoretical considerations.

Specifically, detailed cause of death analyses are needed to better understand the mechanisms giving rise to the so-called "cross-over effect." The shifting period-component percentage, that is, the higher percentage of infant deaths occurring in the postneonatal period, must be examined further so it can be determined if adverse socioeconomic conditions or medical advances are creating this change. If the latter

is the case, we could see higher postneonatal rates and postneonatal component percentages (as in this research) in the future.

A subject that appeared to be of declining interest and importance just two decades ago now appears to be taking on new and different directions, thus generating renewed importance. One case study such as this research cannot confirm or refute or generate all essential elements, but such studies enable us to build upon and further understand the nature of this complex phenomenon which contributes to the cumulation process by which any discipline grows.

BIBLIOGRAPHY

- Adamchak, Donald J., Siegel, Robert E. and Edward G. Stockwell
1976 "Infant Mortality and Socioeconomic Status." Ohio's Health 28 (7): 8-9.
- Adamchak, Donald J. and Edward G. Stockwell
1978 "Trends in the Relationship Between Infant Mortality and Socioeconomic Status: 1950 and 1970." Sociological Focus 11 (1): 47-52.
- Altenderfer, Marion E.
1947a "Relationship Between Per Capita Income and Mortality, in the Cities of 100,000 or More Population." Public Health Reports 26 (November): 1681-1691.
- 1949 "Relationship Between Infant Mortality and Socioeconomic Factors in Urban Areas." Public Health Reports 64 (11): 331-339.
- Anderson, O. W.
1958 "Infant Mortality and Social and Cultural Factors: Historical Trends and Current Patterns. in Patients, Physicians and Illness: Behavioral Science in Medicine, edited by E. Gartly Jaco. Free Press, Glencoe, Illinois, pp. 10-24.
- Annual Meeting of the American Public Health Association
1966 "Indexes of Mortality and Tests of Their Statistical Significance." Human Biology 38 (3): 279-319; discussion, pp. 320-330.
- Antonovsky, Aaron
1967 "Social Class, Life Expectancy and Overall Mortality." Milbank Memorial Fund Quarterly 45 (April): 31-73.
- Bedger, Jean, Gelperin, Abraham and Eveline E. Jacobs
1966 "Socioeconomic Characteristics in Relation to Maternal and Child Health." Public Health Reports 81 (9): 829-833.
- Bendor, Danial E.; Chang Cecil; Fisher, Richard W.; and Nedra
1971 B. Balloc
"Factors Affecting Postneonatal Mortality." HSMHA Health Reports 86 (5): 482-486.

- Benjamin, B.
1965 Social and Economic Factors Affecting Mortality.
Paris: Mouton & Co.
- Blalock, Hubert M., Jr.
1972 Social Statistics. New York: McGraw-Hill Book Co.
- Bogue, Donald J.
1969 Principles of Demography. New York: John Wiley and Sons.
- Bouvier, Leon F. and Jean van der Tak
1976 "Infant Mortality--Progress and Problems." Population Bulletin, Population Reference Bureau, Inc. 31 (1): 1-33.
- Brooks, Charles H.
1975a "The Changing Relationship Between Socioeconomic Status and Infant Mortality: An Analysis of State Characteristics." Journal of Health and Social Behavior 16 (3): 291-303.

1975b "Path Analysis of Socioeconomic Correlates of County Infant Mortality Rates." International Journal of Health Services 5 (3): 499-514.
- Buckatzsch, E. J.
1947 "The Influence of Social Conditions on Mortality Rates." Population Studies 1 (3): 229-248.
- Buetow, Kathleem Carney
1961 "An Epidemiological Approach to the Problem of Rising Neonatal Mortality in Baltimore." American Journal of Public Health 51 (February): 217-227.
- Chabot, Marion Johnson; Garfinkel, Joseph and Margaret W. Pratt
1975 "Urbanization and Differentials in White and Nonwhite Infant Mortality." Pediatrics 56 (5): 777-781.
- Chaddock, Robert E.
1934 "The Significance of Infant Mortality Rates for Small Geographic Areas." Journal of the American Statistical Association 29: 243-249.
- Chandrasekhar, S.
1972 Infant Mortality, Population Growth and Family Planning in India. London: George Allen and Unwin Ltd.
- Chase, Helen C.
1965 "White-Nonwhite Mortality Differentials in the United States." HEW Indicators (June): 27-36.

- 1969 "Registration Completeness and International Comparisons of Infant Mortality." *Demography* 6 (4): 425-433.
- Cohen, Jacob and Patricia Cohen
 1975 *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences*. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Publishers.
- Committee on Maternal and Child Care
 1965 "Reducing Infant Mortality." *Journal of the American Medical Association* 193 (July 26): 310-319.
- Daly, C. and J. A. Heady
 1955 "The Effect of Mother's Age and Parity on Social-Class Differences in Infant Mortality." *Lancet* 1 (February 26): 445-448.
- Department of Health, Education, and Welfare
 1975 *Health in the United States*. Publication No. (NIH).
 1977 *Inventory and Analysis of Federal Population Research*. Publication No. (NIH).
- De Wolff, P. and J. Meerdink
 1954 "Mortality Rates in Amsterdam According to Profession." *Proceedings of the World Population Conference Vol. I*, New York, United Nations (E/Conf. 13/413).
- Dogan, Mattei and Rokkan Stein
 1967 "Quantitative Ecological Analysis: Contexts, Trends, Tasks." *Social Science Information* 6 (6): 35-47.
- Donabedian, Avedis; Rosenfeld, Leonard S. and Edward M. Southern
 1965 "Infant Mortality and Socioeconomic Status in a Metropolitan Community." *Public Health Reports* 80: 1083-1094.
- Douglas, J. W. B.
 1951 "Health and Survival of Infants in Different Social Classes." *Lancet* 2 (September 8): 440-446.
- Duncan, O. D. and Beverly Davis
 1953 "An Alternative to Ecological Correlation." *American Sociological Review* 18: 665-666.
- Erhardt, Carl L.; Govind, Boshi, B.; Nelson, Frieda G.; Kroll, Bernard H.; and Louis Weiner
 1964 "Influence of Weight and Gestation on Perinatal and Neonatal Mortality by Ethnic Group." *American Journal of Public Health* 54 (November): 1841-1855.

- Erhardt, Carl and Joyce E. Berlin (editors)
1974 Mortality and Morbidity in the United States. Cambridge, Mass.: Harvard University Press.
- Falkner, Frank
1969 Key Issues in Infant Mortality. National Institute of Child Health and Human Development, Bethesda, Maryland. U.S. Government Printing Office.
- Foley, Donald L.
1953 "Census Tract and Urban Research." Journal of the American Statistical Association 48 (December): 733-742.
- Fordyce, James E.
1977 "Early Mortality Measures as Indicators of Socioeconomic Well-Being for Whites and Nonwhites: A Re-Appraisal." Sociology and Social Research 61 (2): 125-137.
- Gehlke, C. E. and Katherine Biehl
1934 "Certain Effects of Grouping upon the Size of the Correlation Coefficient in Census Tract Material." Journal of the American Statistical Association 29: 169-170.
- Goodman, Leo A.
1953 "Ecological Regressions and Behavior of Individuals." American Sociological Review 18: 663-664.
- Gover, Mary
1946 "Negro Mortality: The Birth Rate and Infant and Maternal Mortality." Public Health Reports 61 (43): 1529-1538.
- Hauser, Philip M.
1959 "Demographic Indicators of Economic Development." Economic Development and Cultural Change 7: 98-116.
- Hawley, Amos H. and Otis Dudley Duncan
1957 "Social Area Analysis: A Critical Appraisal." Land Economics (November).
- Hunt, Eleanor P.
1964 "Lags in Reducing Infant Mortality." Welfare in Review 2 (April): 1-14.

1967 "Infant Mortality and Poverty Areas." Welfare in Review 5 (August-September): 1-12.
- Hunt, Eleanor P. and Alice D. Chanoweth
1961 "Recent Trends in Infant Mortality in the U.S." American Journal of Public Health 51 (February): 190-207.

- Hunt, Eleanor P. and Stanley Goldstein
 1964 "Trends in Infant and Childhood Mortality." Childrens Bureau Statistical Series 76: U.S. DHEW.
- Hunt Eleanor P. and Earl E. Huyck
 1966 "Mortality of White and Nonwhite Infants in Major U.S. Cities." U.S. DHEW: HEW Indicators (January): 23-41.
- Illsley, R.
 1955 "Social Class Selection and Class Differences in Relation to Stillbirths and Infant Deaths." British Medical Journal 2 (December 24): 1520-1524.
- Institute of Medicine, National Academy of Sciences
 1973 Infant Death: An Analysis by Maternal Risk and Health Care. Washington, D.C.: Institute of Medicine.
- Jiobu, Robert M.
 1972 "Urban Determinants of Racial Differentiation in Infant Mortality." Demography 9: 603-615.
- Kendall, Patricia L. and Paul F. Lazarsfeld
 1950 "Problems of Survey Analysis." in Robert K. Merton and Paul F. Lazarsfeld (eds.), Continuities in Social Research. Glencoe: The Free Press, pp. 133-196.
- Kerlinger, Fred N.
 1973 Foundations of Behavioral Research. New York: Holt, Rinehart and Winston, Inc.
- Kerlinger, Fred N. and Elazar J. Pedhazur
 1973 Multiple Regression in Behavioral Research. New York: Holt, Rinehart and Winston, Inc.
- Kitagawa, Evelyn M.
 1966 "Theoretical Considerations in the Selection of a Mortality Index, and Some Empirical Comparisons." Human Biology 38 (3), Part 2: 293-308.
- Kitagawa, Evelyn M. and Philip M. Hauser
 1968 "Education Differentials in Mortality by Cause of Death: United States, 1960." Demography 5 (1): 318-353.
- 1973 Differential Mortality in the U.S.: A Study in Socio-economic Epidemiology. Cambridge, Mass.: Harvard University Press.
- Kleinman, Joel C.; Feldman, Jacob J.; and Robert H. Hugge
 1976 "Geographic Variations in Infant Mortality." Public Health Reports 91: 423-432.

- Logan, W. P. D.
 1956 "Social Class Variations in Mortality." in J. Spengler and O. D. Duncan ed., Demographic Analysis. Glencoe: Free Press.
- MacMahon, Brian
 1974 "Infant Mortality in the United States." in Erhardt, C. L., and J. E. Berlin (eds.), Mortality and Morbidity in the United States. Cambridge, Mass.: Harvard University Press, pp. 189-209.
- Mabry, John H.
 1958 "Census Tract Variation in Urban Research." American Sociological Review 23: 193-196.
- Markides, Kyriakos S. and Donna Barnes
 1977 "A Methodological Note on the Relationship Between Infant Mortality and Socioeconomic Status with Evidence from San Antonio, Texas." Social Biology 24 (1): 38-44.
- Mathis, Evelyn S.
 1969 "Socioeconomic Characteristics of Deceased Persons." National Center for Health Statistics, Vital and Health Statistics 22 (February).
- Mayer, Albert J. and Richard V. Marks
 1954 "Differentials in Infant Mortality by Race, Economic Level and Cause of Death, for Detroit: 1940 and 1950." Human Biology 26: 143-155.
- Moryama, I. M. and L. Guralnick
 1954 "Occupational and Social Class Differences in Mortality." in Milbank Memorial Fund, Trends and Differentials in Mortality. New York, pp. 61-73.
- Moryama, Iwao M.
 1960 "Recent Change in Infant Mortality Trend." Public Health Reports 75 (5): 391-405.
 1966 "Present Status of Infant Mortality Problem in the U.S." American Journal of Public Health 56 (April): 632-625.
- Morris, Naomi M.; Udry, Richard J.; and Charles L. Chase
 1975 "Shifting Age-Parity Distribution of Births and the Decrease in Infant Mortality." American Journal of Public Health 65 (April): 359-362.

- Morris, J. N. and J. A. Heady
 1955 "Mortality in Relation to the Father's Occupation, 1911-1950." *Lancet* 1 (March 12): 555-559.
- Myers, Jerome K.
 1954 "Note on the Homogeneity of Census Tracts: A Methodological Problem in Urban Ecological Research." *Social Forces* 32 (May): 364-366.
- Nagi, Mostafa H. and Edward G. Stockwell
 1973 "Socioeconomic Differentials in Mortality by Cause of Death." *Health Services Reports* 88 (5): 449-456.
- National Center for Health Statistics
 1965a Infant and Perinatal Mortality in the United States, Vital and Health Statistics, Series 3, No. 4 (October). Washington D.C.: U.S. Government Printing Office.
- 1965b Infant Mortality Trends: United States and Each State, 1930-1964, Vital and Health Statistics, Series 20, No. 1 (November). Washington D.C.: U.S. Government Printing Office.
- 1966a Infant, Fetal, and Maternal Mortality, Vital and Health Statistics, Series 20, No. 3 (September). Washington D.C.: U.S. Government Printing Office.
- 1966b Infant and Perinatal Mortality in Scotland, Vital and Health Statistics, Series 3, No. 5 (November): Washington D.C.: U.S. Government Printing Office.
- 1967a Infant and Perinatal Mortality in Denmark, Vital and Health Statistics, Series 3, No. 9 (November). Washington D.C.: U.S. Government Printing Office.
- 1967b International Comparison of Perinatal and Infant Mortality: The United States and Six West European Countries, Vital and Health Statistics, Series 3, No. 6 (March). Washington D.C.: U.S. Government Printing Office.
- 1967c Infant Mortality Problems in Norway, Vital and Health Statistics, Series 3, No. 8 (October): Washington D.C.: U.S. Government Printing Office.
- 1968a Infant Loss in the Netherlands, Vital and Health Statistics, Series 3, No. 11 (August). Washington D.C.: U.S. Government Printing Office.
- 1968b Infant and Perinatal Mortality in England and Wales, Vital and Health Statistics, Series 3, No. 12 (November). Washington D.C.: U.S. Government Printing Office.

- 1972a Infant Mortality Rates: Socioeconomic Factors, Vital and Health Statistics, Series 22, No. 14 (March). Washington D.C.: U.S. Government Printing Office.
- 1972b Comparison of Neonatal Mortality From Two Cohort Studies, Vital and Health Statistics, Series 20, No. 13 (June). Washington D.C.: U.S. Government Printing Office.
- 1972c Trends in Prematurity, United States: 1950-67, Vital and Health Statistics, Series 3, No. 15 (January). Washington D.C.: U.S. Government Printing Office.
- 1972d A Study of Infant Mortality from Linked Records, Vital and Health Statistics, Series 20, No. 12 (May). Washington D.C.: U.S. Government Printing Office.
- 1973 Infant Mortality Rates: Relationship with Mother's Reproductive History, Vital and Health Statistics, Series 22, No. 15 (April), Washington, D.C.: U.S. Government Printing Office.
- Newman, I. M.
 - 1971 Infant Mortality as a Potential Measure of Community Health in Urban Growth. U.S. Department of Housing and Urban Development (June).
- Newman, John F. and William L. Graves
 - 1972 "Neo-natal Mortality and Socioeconomic Status in a Metropolitan County." Sociological Symposium 8 (Spring): 37-49.
- Newsholme, Arthur
 - 1910 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.
- Norris, Frank D. and Paul W. Shipley
 - 1971 "A Closer Look at Race Differentials in California's Infant Mortality, 1965-67." HSMHA Health Reports 86 (September): 810-814.
- Omran, Abdel R.
 - 1977 "Epidemiologic Transition in the U.S." Population Bulletin, Population Reference Bureau, Inc. 32 (2): 1-42.
- Patno, Mary Ellen
 - 1960 "Mortality and Economic Level in an Urban Area." Public Health Reports 75 (9): 841-851.

- Preston, Samuel H.
1977 Comments for Session on "Measurement and Analyses of Socioeconomic Differentials in Mortality in the United States." American Statistical Association, Annual Meetings, Chicago, Illinois, August 15, 00. 1-3.
- Quinney, Richard
1965 "Mortality Differentials in a Metropolitan Area." Social Forces 43 (December): 222-230.
- Roberts, Robert E. and Cornelius Askew, Jr.
1972 "A Consideration of Mortality in Three Subcultures." Health Services Reports 87 (3): 262-270.
- Robinson, W. S.
1950 "Ecological Correlation and the Behavior of Individuals." American Sociological Review 15: 351-357.
- Rider, Rowland V.; Taback, Matthew; and Hilda Knobloch
1955 "Associations Between Premature Birth and Socioeconomic Status." American Journal of Public Health 45 (August): 1022-1028.
- Schlesinger, Edward R.; Beecroft, Ruth D.; Silverman, Hilda F.; and Norman C. Allaway
1959 "Fetal and Early Neonatal Deaths in Onodaga County, New York.: Public Health Reports 74 (December): 117-1122.
- Schlesinger, Edward R.
1967 "Infant and Perinatal Mortality." American Journal of Public Health 57 (October): 1715-1716.
- Schwirian, Kent P. and Anthony J. Lagreca
1971 "An Ecological Analysis of Urban Mortality Rates." Social Science Quarterly 52 (3): 574-587.
- Shah, Farida K. and Helen Abgey
1971 "Effects of Some Factors on Neonatal and Postneonatal Mortality." Milbank Memorial Fund Quarterly 49 (January): 33-57.
- Shapiro, Sam and Iwao M. Moriyama
1963 "International Trends in Infant Mortality and their Implications for the U.S." American Journal of Public Health 53 (May): 747-760.
- Shapiro, Sam; Ross, Lucille J.; and Herbert S. Levine
1965 "Relationship of Selected Prenatal Factors to Pregnancy Outcome and Congenital Anomalies." American Journal of Public Health 55 (February): 268-282.

- Shapiro, Sam; Schlesinger, Edward R.; and Robert E. L. Nesbitt, Jr.
 1968 Infant, Perinatal, Maternal and Childhood Mortality in the U.S. Cambridge, Mass.: Harvard University Press.
- Shevky, Eshref and Marilyn Williams
 1949 The Social Areas of Los Angeles. Berkeley and Los Angeles: University of California Press.
- Shevky, Eshref and Wendell Bell
 1955 Social Area Analysis. Westport, Conn.: Greenwood Press, Publishers.
- Shin, Eui Hang
 1975a "Black-White Differentials in Infant Mortality in the South, 1940-1970." Demography 12 (1): 1-19.
 1975b "Economic and Social Correlates of Infant Mortality: A Cross-Sectional and Longitudinal Analysis of 63 Selected Countries." Social Biology 22 (Winter): 315-325.
- Shryock, Henry S.; Siegel, Jacob S.; and Edward G. Stockwell
 1976 The Methods and Materials of Demography. New York: Academic Press.
- Sommers, Herbert J.
 1942 "Infant Mortality in Rural and Urban Areas." Public Health Reports 57 (October 2): 1494-1501.
- Spiegelman, Mortimer
 1954 "Recent Trends and Determinants of Mortality in Highly Developed Countries." In Milbank Memorial Fund, Trends and Differentials in Mortality. New York. pp. 51-60.
 1968 "Mortality in the United States: A Review and Evaluation of Special Reports of the National Center for Health Statistics." Demography 5 (1): 525-533.
- Stockwell, Edward G.
 1960a "The Measurement of Economic Development." Economic Development and Cultural Change 8 (4): 419-432.
 1960b "Socio-Economic Mortality Differentials in Hartford, Conn., and Providence, R.E., 1949-1951: A Methodological Critique." Unpublished Ph.D. Thesis, Brown University.

- 1961 "Socioeconomic Status and Mortality in the U.S." Public Health Reports 76 (12): 1081-1086.
- 1962a "Infant Mortality and Socioeconomic Status: A Changing Relationship." Milbank Memorial Fund Quarterly 40 (January): 101-111.
- 1962b "The Relationship between Population Growth and Economic Development." American Sociological Review 27 (2): 250-252.
- 1963a "A Critical Examination of the Relationship Between Socioeconomic Status and Mortality." American Journal of Public Health 53 (6): 956-964.
- 1963b "Fertility, Mortality, and Economic Status of Underdeveloped Areas." Social Forces 41 (4): 390-395.
- 1963c "Socio-Economic and Demographic Differences Among Underdeveloped Areas." Rural Sociology 28 (2): 165-175.
- 1966a "Some Demographic Correlates of Economic Development." Rural Sociology 31 (2): 216-224.
- 1966b "Use of Socioeconomic Status as a Demographic Variable." Public Health Reports 81 (11): 961-966.
- Stockwell, Edward G. and Mostafa H. Nagi
1968 The Social Areas of Metropolitan Connecticut, Stores AES, Bulletin 404 (March).
- Stockwell, Edward G. and Bruce H. Hutchinson
1975 "A Note on Mortality Correlates of Economic Development." Population Review 19 (1-2): 46-50.
- Stockwell, Edward G. and Karen A. Laidlaw
1977 "Infant Mortality and Socioeconomic Status Among Ohio Counties, 1969-71." The Ohio Journal of Science 77(2): 72-75.
- Stockwell, Edward G.; Wicks, Jerry W.; and Donald J. Adamchak
1977 "Research on the Relationship Between Socioeconomic Status and Mortality in the United States: 1960-1975." Presented at the 1977 Annual Meetings of the American Statistical Association, Chicago, Illinois, (August).
- Stockwell, Edward G. and Donald J. Adamchak
1978 "Changing Patterns of Infant Mortality Among Social Areas in Toeldo, Ohio: 1950-1970." East Lakes Geographer (Forthcoming).

Struening, Elmer L., et al.

- 1973 "Family, Ethnic and Economic Indicators of Low Birth Weight and Infant Mortality: A Social Area Analysis." *Annals of the New York Academy of Sciences* 218 (June 22): 87-107.

Szabady, Egon

- 1963 "Recent Changes in the Socio-Economic Factors of Hungary's Mortality." in *International Population Conference, Ottawa, Liege, International Union for the Scientific Study of Population.*

Tuckman, Jacob, et al.

- 1965 "Occupational Level and Mortality." *Social Forces* 43 (4): 575-577.

U.S. Bureau of the Census

- 1952 *Census of Population and Housing: 1950, Census Tracts, Final Report PC (1), Toledo, Ohio-Michigan, SMSA.* Washington D.C.: U.S. Government Printing Office.
- 1962 *Census of Population and Housing: 1960, Census Tracts, Final Report PC (1), Toledo, Ohio-Michigan, SMSA.* Washington D.C.: U.S. Government Printing Office.
- 1972 *Census of Population and Housing: 1970, Census Tracts, Final Report PHC (1)-215, Toledo, Ohio-Michigan, SMSA.* Washington D.C.: U.S. Government Printing Office.

U.S. Department of Health, Education, and Welfare

- 1977 *Provisional Statistics. Annual Summary for the United States, 1976, (PHS) 78-1120, vol. 25. no. 13, December 12.*

Van de Geer, John P.

- 1971 *Introduction to Multivariate Analysis for the Social Sciences.* San Francisco: W. H. Freeman and Co.

Willie, Charles. V.

- 1959 "A Research Note on the Changing Association Between Infant Mortality and Socioeconomic Status." *Social Forces* 37 (March): 221-227.

Willie, Charles V. and William B. Rothney

- 1962 "Rocial, Ethnic, and Income Factors in the Epidemiology of Neonatal Mortality." *American Sociological Review* 27: 522-526.

Woodbury, Robert Morse

- 1925 *Causal Factors in Infant Mortality.* U.S. Department of Labor, Childrens Bureau, Publication No. 142. Washington D.C.: U.S. Government Printing Office.

1926 Infant Mortality and Its Causes. Baltimore: The Williams and Wilkins Co.

World Health Organization

1957 International Classification of Diseases. Vol. 1, 1955 revision, Geneva.

Wright, Nicholas H.

1975 "Family Planning and Infant Mortality Rate Decline in the U.S." American Journal of Epidemiology 101 (3): 182-187.

Yankauer, Alfred, Jr.

1950 "The Relationship of Fetal and Infant Mortality to Residential Segregation: An Inquiry into Social Epidemiology." American Sociological Review 15: 644-648.

Yeracaris, Constantine A.

1955 "Differential Mortality, General and Cause-Specific in Buffalo, 1939-1941." Journal of the American Statistical Association 50: 1235-1247.