

Infant Mortality in Pennsylvania, 1954-58

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ONE of the most striking changes in health statistics in Pennsylvania and the United States can be seen in the infant mortality figures recorded during the last half century. An examination of these data indicates that the infant death rate in Pennsylvania has been reduced from 145.8 per 1,000 live births during the period 1906-09 to less than 25 infant deaths per 1,000 live births during the period 1954-58. A comparable reduction is observable in national statistics; 95.7 during 1915-19 to less than 27 during 1954-58.

Table 1 indicates infant death rates for Pennsylvania, 1906-58, and the expanding birth registration area of the United States, 1915-58. Sharp decreases from period to period occurred in Pennsylvania from 1906 to the late forties and early fifties, but the rate has essentially stabilized since 1953. The period of rapid decline for the United States ended in the mid-forties although the trend remained downward until 1953. The United States rate for each year since 1953 shows very little variation.

Stabilization of the infant death rate at this level is of great concern to the medical profession, since further reduction in mortality during the first year of life is possible. However, from a statistical point of view, if stabilization of the infant death rate has occurred, it is meaningful and is of interest to determine whether an annual change in the rate (either upward or downward) is statistically significant or whether the change is within the inherent variability of a stable rate. Identification of the components of the change in rate is

equally important for planning purposes, regardless of the presence or absence of statistical significance.

White and Nonwhite Mortality

Levels of infant mortality are significantly affected by sex, race, and age at death. These differentials are apparent in table 2. Approximately 42 percent of the total infant mortality occurs within 1 day of birth, 68 percent in less than a week, and 77 percent before 4 weeks of life are completed. Male mortality is about one-third greater than female mortality for both races and at each age level, and nonwhite mortality is about twice as great as white mortality for each sex and at each age level. Even though the mortality differentials by sex and age are large, these factors do not ordinarily contribute significantly to changes in the total rate because their proportional effect on total mortality remains essentially stable.

The greatest differential in mortality is between the white and nonwhite components, and this differential can influence the total mortality rate without any change in the race-specific rates. For example, in 1957 the crude infant death rate was 24.5, the white rate was 22.3, and the nonwhite rate was 44.7; the rates being based on 254,997 live births, of which 229,793 were white and 25,204 nonwhite. Had the 1957 race-specific rates (22.3 and 44.7) remained constant and been applied to the 1958 birth cohort (white, 224,043 and nonwhite, 25,767), there would have been 4,996 white infant deaths and 1,152 nonwhite infant deaths. The total infant mortality rate would then be $(6,148/249,810) \times 1,000$, or a rate of 24.6 per 1,000 live births. While this is a minimal change in

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Table 1. Infant death rates and percentage change in rate: Pennsylvania, 1906-58 and the expanding birth registration area of the United States, 1915-58

Period	Pennsylvania		United States	
	Rate per 1,000 live births	Percentage decrease from previous period ¹	Rate per 1,000 live births	Percentage decrease from previous period ¹
1906-09 ²	145.8			
1910-14 ²	123.2	15.5		
1915-19 ²	112.7	8.5	95.7	
1920-24 ²	88.4	21.6	76.7	19.9
1925-29 ²	75.2	14.9	69.0	10.0
1930-34 ²	60.6	19.4	60.4	12.5
1935-39 ²	48.7	19.6	53.2	11.9
1940-44 ²	40.3	17.2	42.4	20.3
1945	37.9	6.0	38.3	9.7
1946	33.0	12.9	33.8	11.7
1947	31.1	5.8	32.2	4.7
1948	28.4	8.7	32.0	.6
1949	29.2	-2.8	31.3	2.2
1950	27.6	5.5	29.2	6.7
1951	26.0	5.8	28.4	2.7
1952	26.1	-.4	28.4	.0
1953	25.7	1.5	27.8	2.1
1954	24.9	3.1	26.6	4.3
1955	24.6	1.2	26.4	.8
1956	24.5	.4	26.0	1.5
1957	24.5	.0	³ 26.4	-1.5
1958	25.5	-4.1	³ 26.9	-1.9

¹ Minus sign means percentage increase over previous period.

² Average rate shown for period.

³ Provisional.

NOTE: Rates shown for Pennsylvania prior to 1940 are based on live births and infant deaths occurring in Pennsylvania; after 1939 the rates shown are based on resident data.

SOURCES: National Office of Vital Statistics, Public Health Service, and for Pennsylvania data in all tables, statistical methods section, division of statistics and records, Pennsylvania Department of Health.

Table 2. Infant death rates per 1,000 live births of Pennsylvania residents, by age at death, sex, and race, averages 1954-57 and 1954-58

Sex and race	Average death rate 1954-57				Average death rate 1954-58			
	Total: under 1 year	Under 1 day	Under 1 week ¹	Under 4 weeks	Total: under 1 year	Under 1 day	Under 1 week ²	Under 4 weeks
Total	24.6	10.3	16.7	19.0	24.8	10.3	17.0	19.1
Male	27.9	11.5	18.9	21.6	28.2	11.6	19.3	21.8
Female	21.2	9.0	14.3	16.1	21.3	9.0	14.5	16.3
White	22.7	9.4	15.4	17.5	22.7	9.3	15.5	17.6
Male	25.8	10.4	17.5	20.1	25.9	10.5	17.7	20.1
Female	19.3	8.2	13.1	14.8	19.3	8.1	13.2	14.9
Nonwhite	43.3	18.9	28.9	32.4	44.5	19.4	30.5	33.5
Male	48.3	21.5	32.3	36.4	49.8	22.0	34.2	37.5
Female	38.2	16.1	25.3	28.4	39.1	16.6	26.8	29.4

¹ Average rate 1956-57.

² Average rate 1956-58.

the total rate, it is a result of an increase in the proportion of nonwhite live births from 9.9 to 10.3 percent of total live births and not the result of any change in either the white or nonwhite rate.

Conversely, changes may occur in both the white and nonwhite rate with no discernible change in the total rate. The white infant death rate in 1957 was 22.3, or slightly lower than the

1956 white rate of 22.6, while the nonwhite rate in 1957 was 44.7, an increase over the 1956 rate of 42.1. A 0.3 per 1,000 decrease in the white rate counterbalanced a 2.6 per 1,000 increase in the nonwhite rate; the overall crude infant mortality rate was 24.5 for both 1956 and 1957. Because of the mortality differentials between sex, race, and age, and their individual impact on the total infant death rate, no meaningful ap-

Table 3. Infant death rates per 1,000 live births of Pennsylvania residents by sex and race, 1954-58 and averages 1954-57 and 1954-58

Sex and race	1954	1955	1956	1957	Average 1954-57	1958	Average 1954-58	P ¹
Under 1 year								
Total.....	24.9	24.6	24.5	24.5	24.6	25.5	24.8	0.01
Male.....	28.4	28.0	28.2	27.1	27.9	29.1	28.2	.02
Female.....	21.3	21.0	20.6	21.7	21.2	21.7	21.3	.28
White.....	23.1	22.7	22.6	22.3	22.7	22.8	22.7	.79
Male.....	26.4	26.0	26.3	24.6	25.8	26.1	25.9	.57
Female.....	19.7	19.1	18.8	19.8	19.3	19.2	19.3	.81
Nonwhite.....	43.5	43.1	42.1	44.7	43.3	48.9	44.5	.0004
Male.....	49.8	47.1	46.6	49.9	48.3	55.2	49.8	.002
Female.....	37.0	39.0	37.4	39.3	38.2	42.5	39.1	.03
Under 4 weeks								
Total.....	19.1	19.2	18.8	18.8	19.0	19.7	19.1	.05
Male.....	21.9	22.1	21.6	20.9	21.6	22.5	21.8	.05
Female.....	16.1	16.0	15.9	16.5	16.1	16.8	16.3	.09
White.....	17.9	17.7	17.4	17.2	17.5	17.7	17.6	.52
Male.....	20.6	20.6	20.1	19.1	20.1	20.3	20.1	.67
Female.....	15.1	14.6	14.6	15.1	14.8	14.9	14.9	.81
Nonwhite.....	31.2	33.4	31.8	33.2	32.4	37.3	33.5	.0004
Male.....	36.0	37.0	35.6	37.0	36.4	41.4	37.5	.01
Female.....	26.3	29.8	27.9	29.3	28.4	33.2	29.4	.004
Under 1 day								
Total.....	10.0	10.4	10.3	10.3	10.3	10.5	10.3	.38
Male.....	11.2	11.7	11.9	11.1	11.5	12.0	11.6	.14
Female.....	8.8	9.0	8.7	9.5	9.0	8.9	9.0	.74
White.....	9.3	9.5	9.4	9.3	9.4	9.2	9.3	.38
Male.....	10.3	10.7	10.8	9.9	10.4	10.6	10.5	.55
Female.....	8.2	8.2	7.9	8.6	8.2	7.8	8.1	.19
Nonwhite.....	17.4	19.3	18.7	19.9	18.9	21.2	19.4	.02
Male.....	20.2	21.6	21.8	22.3	21.5	23.9	22.0	.10
Female.....	14.5	16.9	15.5	17.4	16.1	18.5	16.6	.06

¹ P = the probability that a difference as great as or greater than the observed difference between the 1958 rate and the 1954-57 average rate could occur due to chance alone. The test used was:

$$\frac{\text{difference}}{\text{S.E. diff.}} = \frac{p_1 - p_2}{\sqrt{\frac{pq}{n_1} + \frac{pq}{n_2}}}$$

where p_1 = 1958 rate
 p_2 = 1954-57 average rate
 p = 1954-58 average rate
 q = 1-p
 n_1 = number of live births during 1958
 n_2 = number of live births during 1954-57

praisal of the 1958 infant death rate in relation to previous years can be made without an examination of the component parts of the rate on a sex, race, and age-specific basis.

In table 3 infant death rates by sex and race for each year 1954-58 and the average rates for the 4-year period 1954-57 and the 5-year period 1954-58 are indicated. A test of the significance of the difference between the 1958 rate and 1954-57 average rate was made for each sex-race class.

In the table, *P* is the probability that a difference as great as or greater than the observed difference between the 1958 rate and the 1954-57 average rate could occur due to chance alone. If *P* = 0.05 or any smaller value is established as significant, as is conventional, the differences in the white rates of the magnitude observed could occur very frequently due to chance alone, while the nonwhite differences are large enough to be statistically significant. That is, it is very unlikely that 1958 nonwhite mortality is consistent with the 1954-57 nonwhite mortality level.

Comparable data for neonatal death rates (infants under 4 weeks) show similar results (table 3). The 1958 rates for white infants are not significantly different from the 1954-57 average, and the nonwhite rates differ significantly.

In natal day mortality, differences in the white rates again are not significant (table 3). The nonwhite differences are either significant or approach significance. However the probabilities shown indicate that these changes are considerably more likely to be due to inherent

variability than were the 1958 nonwhite rates at other age levels.

Table 4 indicates mortality rates of infants living less than 1 week. The differences tested in this table are between the 1958 rate and the average rate for 1956-57, because data for 1954 and 1955 were not classified to define infants living less than 1 week. The significance of the change in the nonwhite rates is comparable to that found for total nonwhite infant mortality and for nonwhite neonatal mortality. The difference in white rates is not significant, but the probability that differences of this magnitude are due to chance alone is much less than was found for white infant and white neonatal mortality.

These findings indicate that death rates of white infants (at each age level) for 1958 are not significantly higher than the average white mortality observed during the previous 4 years. Mortality of white infants for the 5-year period 1954-58 has been strikingly consistent, and it may be said that the white infant mortality rate has stabilized at a level of approximately 22.7 per 1,000 white live births. (This, of course, does not obviate further reduction of the rate by the application of the full potential of medical and health facilities.)

Area and Cause of Death

The 1958 nonwhite infant death rates (at each age level) were found to be significantly greater

Table 4. Death rates of infants living less than 1 week per 1,000 live births of Pennsylvania residents, by sex and race, 1956-58, and averages 1956-57 and 1956-58

Sex and race	1956	1957	Average 1956-57	1958	Average 1956-58	<i>P</i> ¹
Total.....	16.7	16.7	16.7	17.6	17.0	0.004
Male.....	19.3	18.5	18.9	20.2	19.3	.006
Female.....	14.0	14.7	14.3	14.9	14.5	.15
White.....	15.5	15.2	15.4	15.8	15.5	.21
Male.....	18.0	16.9	17.5	18.2	17.7	.14
Female.....	12.8	13.4	13.1	13.2	13.2	.82
Nonwhite.....	28.1	29.6	28.9	33.8	30.5	.0001
Male.....	31.5	33.0	32.3	38.0	34.2	.004
Female.....	24.5	26.1	25.3	29.5	26.8	.02

¹ *P* = the probability that a difference as great as or greater than the observed differences between the 1958 rate and the 1956-57 average rate could occur due to chance alone. See table 3 for formula used to test significance of the observed difference.

Table 5. Nonwhite infant death rates per 1,000 live births by age among residents of Philadelphia and Allegheny Counties and the rest of the State, 1954-58, and averages 1954-57 and 1954-58

Age at death and area	1954	1955	1956	1957	Average 1954-57	1958	Average 1954-58	P ¹
Under 1 year:								
Philadelphia.....	46.9	45.6	42.5	47.0	45.4	51.7	46.8	0.001
Allegheny.....	36.4	38.2	44.8	42.9	40.7	45.8	41.8	.16
Rest of State.....	39.0	35.3	39.1	38.1	37.9	42.9	39.0	.08
Under 4 weeks:								
Philadelphia.....	33.7	36.2	33.1	34.9	34.5	40.4	35.7	.001
Allegheny.....	29.2	32.6	33.8	32.2	32.0	35.2	32.7	.33
Rest of State.....	25.8	25.9	26.8	28.1	26.7	29.9	27.4	.19
Under 1 day:								
Philadelphia.....	18.3	20.6	19.6	21.1	20.0	23.2	20.7	.01
Allegheny.....	15.8	20.9	20.3	19.4	19.1	18.9	19.1	.94
Rest of State.....	16.0	14.1	15.1	16.3	15.4	17.1	15.8	.36

¹ P=the probability that a difference as great as or greater than the observed difference between the 1958 rate and the 1954-57 average rate could occur due to chance alone. See table 3 for formula used to test significance of the observed difference.

than the nonwhite mortality levels during the previous 4 years. The State nonwhite mortality rate is determined to a large degree by mortality levels in two counties. Approximately 63 percent of the nonwhite births each year are to residents of Philadelphia and approximately 15 percent to Allegheny residents. The remaining 22 percent of nonwhite births occur in such small numbers when allocated to specific county of residence that analysis by individual county is not feasible. Table 5 indicates nonwhite infant, neonatal, and natal day mortality for Philadelphia and Allegheny Counties and the rest of the State for the period 1954-58. When the 1958 rates are compared with the 1954-57 mortality level, only the differences observed for Philadelphia are significant at each age level.

A detailed analysis of rates by county has not been attempted (other than that shown for Philadelphia and Allegheny) because the frequencies in most counties are so small that quite wide variation in annual rates can occur without being statistically significant. The infant death rate for the 45 nonmetropolitan counties was the same in 1957 and 1958 (table 6). Births in these counties are predominantly white and are only 22 percent of the State total. The 1958 rate for the 22 metropolitan counties is greater than the 1957 rate (26.0 and 24.8); however, several of the standard metropolitan areas show decreases in 1958.

When infant mortality by cause of death is

examined, it is found that the only noticeable change during the period occurs in 1958. This is a reduction in the number of deaths attributed to "other diseases of the lung and pleural cavity" and a corresponding increase in the number of deaths classified as "ill-defined diseases of early infancy." This is an artificial change due to a 1958 revision in the rules for coding causes of death under the provisions of

Table 6. Infant death rate per 1,000 live births of residents of standard metropolitan areas of Pennsylvania, 1957 and 1958

Area	1957	1958
State total.....	24.5	25.5
Nonmetropolitan counties (45).....	23.4	23.4
Metropolitan counties (22).....	24.8	26.0
Allentown-Bethlehem-Easton (Lehigh and Northampton Counties).....	20.5	22.8
Altoona (Blair County).....	22.8	29.4
Erie (Erie County).....	23.4	29.1
Harrisburg (Dauphin and Cumberland Counties).....	21.5	25.6
Johnstown (Cambria and Somerset Counties).....	28.6	23.8
Lancaster (Lancaster County).....	23.4	18.8
Philadelphia (Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties).....	27.0	30.0
Pittsburgh (Allegheny, Beaver, Washington, and Westmoreland Counties).....	22.8	22.6
Reading (Berks County).....	22.2	22.7
Scranton (Lackawanna County).....	25.5	23.6
Wilkes-Barre and Hazleton (Luzerne County).....	25.8	21.7
York (York County).....	22.1	22.3

the seventh revision of the International Statistical Classification of Diseases, Injuries, and Causes of Deaths. During 1954-57, deaths of infants from "hyaline membrane" were coded to "other diseases of the lung and pleural cavity," while in 1958 these deaths were assigned to "ill-defined diseases of early infancy."

The effect of this revision in coding instructions may be seen in the following table.

Cause	Number of infant deaths				
	1958	1957	1956	1955	1954
Other diseases of the lung and pleural cavity (code 527)-----	13	126	114	105	80
Ill-defined diseases of early infancy (code 773)-----	442	210	225	221	213

Other factors which affect infant mortality such as birth weight, birth order, and age of mother have not been analyzed in detail as have sex, race, and age at death. However it has been observed during this period that there has not been any material change in the proportional distribution of birth weights, birth orders, and ages of mother in the total birth population. The increase in the nonwhite death rate may very well be due to changes in the nonwhite birth population that are not apparent in the total population. Further study of the effect of birth weight, birth order, and age of mother, especially in the nonwhite segment, will be conducted when the 1959 data are available.

All of the rates shown are based on births and deaths occurring in the same year. It is unlikely that computation of these rates on a

cohort basis would affect the findings of this study because the number of white births each year has been fairly constant and the number of nonwhite births has increased only slightly each year. Under these conditions the relative difference in rate from year to year is much the same for each race group using either method of computation.

Summary

An investigation of infant mortality in Pennsylvania at several age levels (under 1 day, under 1 week, under 4 weeks, under 1 year) during 1954-58 indicates that the white mortality rate has essentially stabilized and that the 1958 rate falls within the expected range of inherent variability associated with the average of the 1954-57 mortality level.

The difference between the 1958 nonwhite infant mortality and the 1954-57 average rate at each age level was found to be statistically significant; that is, it is highly unlikely that differences this great could occur due to chance alone. While the nonwhite rates increased throughout the State, only in Philadelphia County were the 1958 rates found to be significantly greater than the 1954-57 averages.

Infant mortality during 1958 in the standard metropolitan areas of the State increased slightly over the 1957 rate, while mortality in the nonmetropolitan counties was the same in both 1957 and 1958.

No real change in mortality from specific causes of death can be identified.

Performance Standards for Health Agencies

Minimum standards of performance for local health departments will be put into effect by the Public Health Council of the New Jersey Department of Health on April 1, 1961. The council had previously prepared a list of recognized activities for health departments, recommended by a committee of local health officers in 1957. The same committee drafted the minimum standards of performance. Its recommendations were adapted with refinements after a public hearing. Copies are available from the New Jersey Department of Health.

A summary of the activities of the New Jersey Department of Health appears in its annual report, dated March 1, 1960.