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THE POOR AT BIRTH: INFANT AUXOLOGY AND MORTALITY AT PHILADELPHIA'S ALMSHOUSE HOSPITAL, 1848-1873

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ABSTRACT

This paper presents an analysis of birthweights and infant mortality in mid-nineteenth century Philadelphia using obstetrics records of Philadelphia's Almshouse hospital, an institution for the poor and their offspring. Children of the poor weighed between 2,900 and 3,200 grams on average at birth, or about the 10th to 25th centile of modern birthweight standards. Birthweights declined during the Civil War decade, consistent with the poor state of the economy in the 1860s. Because birthweights were lower than modern standards the urban poor suffered from higher rates of infant mortality than today. But infant mortality was far worse than that expected from a modern schedule of mortality by birthweight, and a major determinant of excess mortality appears to be the poor quality of nineteenth century obstetrics.

KEY WORDS: birthweights, infant mortality in nineteenth century, urban poor

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The health and nutritional status of the urban poor figure prominently in historical discussions of living standards in mid-nineteenth century America. Contemporary observers and modern historians have charged that a substantial fraction of working-class families were unable to purchase adequate food, clothing, and shelter, and that their health and nutritional status suffered the expected consequences (Griscom, 1845; Commons, et al., 1918; Ware, 1924; Sullivan, 1955; Wilentz, 1984). There is also an emerging debate on the possible change in standards of living in mid-century. According to Komlos (1987) an increase in the relative price of food after 1840 led to a reduction in its per capita consumption. Rapid urbanization may have resulted in deteriorating health, mortality, and environmental conditions, and living standards may have worsened in the North during the Civil War (Yasuba, 1962; Fogel, 1988; Mitchell, 1903; Fite, 1910; Lebergott, 1964; Engerman, 1966; DeCanio and Mokyr, 1977).

This paper presents an analysis of birthweights and infant mortality in mid-nineteenth century Philadelphia, using obstetrics records from Philadelphia's Almshouse hospital, an institution for the poor and their offspring. Through the lens of anthropometric data we examine the extent of relative deprivation of the urban poor, changes in standards of living in mid-century and during the Civil War, and the relationship between birthweight and infant mortality.

Recent work by economic historians has demonstrated the value of anthropometric data in studying patterns of health and nutritional status in nineteenth-century America (Steckel, 1979b; Margo and Steckel, 1982, 1983; Fogel, et al., 1983; Fogel, 1987; Steckel, 1986a, 1986b; Komlos, 1987; Margo and Steckel, 1988). Union Army muster rolls reveal that the urban poor achieved only about the 25th centile of modern adult height standards around 1860.[1] But short stature

[1] This statement is based on the assumption that the urban poor would mostly mature to be unskilled laborers in urban areas, whose adult heights reached the 25th centile; see Margo and Steckel (1983).

in adults is cumulative, reflecting nutritional deficiencies and environmental insults during the growing years and not just deprivation at any one point in time. Evidence on adult heights can be supplemented with that for children (Tanner, 1982). Of particular value is evidence on birthweights. Modern studies have shown that variations in birthweight are sensitive to a variety of socioeconomic and demographic factors and that birthweight is an excellent overall indicator of newborn health. Low birthweight, defined to be 2,500 grams or less, is associated today with a significantly increased risk of neonatal mortality (Shapiro, Schlesinger, and Nesbitt, 1968; for general references in the area see Tanner, 1978; and Hurley, 1980). Previous studies have suggested that low birthweights may have been an important determinant of short adult stature and of high rates of neonatal mortality in the past (Tanner, 1982; Floud and Wachter, 1982; Steckel, 1986a; Fogel, 1987). More important is that birthweight is a contemporaneous indicator of the standard of living.

The Almshouse data suggest that birthweights among the urban poor averaged between 2,900 and 3,200 grams (6.4 to 7.1 pounds) in the 1850s and 1860s and that birthweights fell sharply during the Civil War years. Compared with modern standards the urban poor were lighter at birth, and their mortality experience as infants was considerably worse than that predicted from a modern schedule of mortality by birthweight. A key determinant of mortality at the Almshouse was the poor quality of nineteenth-century obstetrics practice (Shorter, 1981; Leavitt, 1986). In particular, the failure of obstetricians to intervene in lengthy or difficult labors -- and when intervention took place, the use of forceps -- led to a higher probability of infant death.

1. The Data

The Almshouses of Philadelphia -- the poor house, the work house, and the hospital -- originated in the eighteenth century. Like their counterparts in other cities, the institutions served the poor and their offspring.[2] Beginning in the nineteenth century physicians attending births at the Almshouse hospital recorded information on the mother, the delivery, and the infant, including (beginning in 1848) weight at birth. The data base for the paper consists of all 4,841 births occurring at the hospital from 1848 to 1873.[3]

The Almshouse hospital was an institution where poor women, regardless of age, marital status, nativity, and health, gave birth (see Table 1 for sample statistics). Approximately 34 percent were over age 25, only 17 percent were under 20 years old, and for 40 percent, the birth was at least their second. Nearly half (42 percent) claimed to be married or widowed. The majority of mothers (69 percent) were foreign born, primarily Irish (50 percent), and only 17 percent were native to Philadelphia.

Pregnant women came to deliver their babies at the Almshouse hospital through varied channels. Many entered the poor house or the work house well before giving birth, brought there by the Guardians of the Poor, a civil group which scoured the city for poor in need of relief. The majority of the women were destitute, abandoned, and without other housing; they were, in other words, the poorest of the poor. Women close to labor and those suffering from venereal and other

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[2] See Lawrence (1905) and Croskey (1929) for institutional histories of the Almhouses of Philadelphia. Alexander (1980) discusses the early history of poor relief in Philadelphia.

[3] "Almshouse Hospital, Register of Births, 1808-1885," Record Series 35.157, Archives of the City and County of Philadelphia. The records are missing from 1874 to 1877. From 1877 to 1885 the register lists only the child's name, race, and sex.

diseases were brought directly to the hospital; they spent little or no time at the poor house or the work house prior to giving birth. A final group, typically foreign born, went to the hospital to give birth because, being new to the city, they had no other choice.

Mean birthweights of Almshouse infants by year of birth are graphed in Figure 1. While the overall mean was 3,377 grams, the average birthweight fluctuated from year to year and across decades. The average birthweight rose in the early 1850s reaching a peak in 1856, fell through the Civil War years reaching a trough in 1866, and then increased from 1866 to 1873.

An analysis of the determinants of birthweight reveals the role of maternal characteristics, including nativity, and also supports the general reliability of the data. Two regressions are reported in Table 2. Regression (1) was estimated on a sub-sample for which information on gestational age was available (1854 to 1873) and regression (2) used the full sample. The dependent variable is measured in grams. While the R^2's are relatively low, the variance explained is higher when gestational age is included.

Demographic characteristics of the mother influenced birthweight. Birthweight increased (at a decreasing rate) with maternal age and with parity.[4] One might expect married women (or widows) to be better-off economically than single women, and hence to give birth to heavier babies.[5] The effects of marital status are small and statistically insignificant, however, in both regressions. Mothers who were diagnosed as "alcoholic" or having venereal disease had babies

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[4] These patterns are typical of modern data; see, for example, Hardy and Mellits (1977).

[5] In their study of birthweights in nineteenth-century Montreal, Ward and Ward (1984, p. 335) found that unmarried women bore babies who were, on average, 100 grams lighter than babies born to married women.

that were hundreds of grams lighter.[6]

Ethnic and rural-urban differences in diet, socioeconomic status, disease environment, and the frequency and intensity of female labor force participation might be expected to produce ethnic and rural-urban differences in birthweights.[7] All ethnic and nativity groups had lighter babies than the Irish. The weight gap between Irish and non-Irish infants -- between 90 and 200 grams, depending on the regression -- is similar to the gap observed in Montreal among the same groups in the late-nineteenth century (Ward and Ward, 1984).[8] Mothers native to Philadelphia gave birth to infants who were significantly lighter than did mothers born elsewhere in the United States.[9]

The sex and gestational age of the child affected birthweight. Males were approximately 100 grams heavier at birth, identical to the difference observed today (Tanner, 1978). Birthweight increased (at a decreasing rate) with gestational age, also a pattern found in modern data. The coefficients of several

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[6] The effects of disease and alcohol consumption on fetal growth have been widely noted in the literature; see Tanner (1978).

[7] Because birthweights vary with mother's height, ethnic differences in maternal stature could produce ethnic differences in birthweight. This factor could not be investigated because maternal stature was not reported (but see footnote 14).

[8] The reason why Irish babies were heavier is unclear, although one possibility is ethnic differences in mother's height: Irish mothers may have been taller than other mothers. This is suggested by the fact that Irish males were taller as adults than other European males in the mid-nineteenth century, and that the Irish who migrated to the United States were probably taller than the Irish who remained behind. See Steckel (1986b) for evidence on ethnic differences in adult height and Margo and Steckel (1983) on the relationship between migration and height.

[9] According to Margo and Steckel's (1983) study of antebellum heights, persons born in large cities (population of 10,000 or more) were significantly shorter as adults than persons born in rural areas. Thus our finding suggests that the rural-urban difference in adult height may have originated in part in the fetal period.

independent variables -- for example, mother's age and ethnicity, and whether the mother was venereal or an alcoholic -- differ in magnitude between the regressions with and without gestational age, which suggests that these characteristics influenced the extent of prematurity along with birthweight.

Previous studies have revealed monthly variation in infant mortality in nineteenth-century cities (Cheney, 1984). Seasonal variation in wages, employment, food prices, and the disease environment may have caused variation in birthweight which, in turn, may explain monthly variation in infant mortality.[10] The regressions provide some indication that birthweights varied seasonally: infants born in the winter and summer months were lighter than those born in the spring or fall. But the differences are small, suggesting that seasonal variation in birthweights cannot explain monthly variation in infant mortality.[11]

Changes in birthweight over time were examined by a series of dummy variables for various time periods. The results demonstrate that the time patterns evident in Figure 1 are not due to changes in the composition of the sample over time. After controlling for other factors, birthweights rose in the late 1850s but declined sharply (by 220 to 240 grams) during the Civil War decade. The recovery in birthweights that began at the end of the 1860s was insufficient, however, to reverse the decline.

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[10] Cheney (1984) argues that some portion of high infant mortality during the summer months may have been related to nutritional deficiencies.

[11] Steckel (1986b) shows that, among slaves, seasonal variations in birthweight were a major factor behind seasonal variations in infant mortality.

2. Birthweights

Modern birthweight standards are 3,400 grams for females and 3,500 grams for males, or an average of 3,450 grams (Tanner, 1978). Compared with modern standards, Almshouse infants appear to have been relatively healthy at birth (recall the mean is 3,377 grams). Furthermore, only during the Civil War decade did birthweights fall below levels considered normal by current standards.[12] But, as pointed out previously, the hospital served an impoverished clientele, and one might have expected birthweights of Almshouse infants to have been even lower than those of their richer contemporaries and considerably lower than today. Several biases in the data can be considered.

Systematic measurement error is one possibility. No description of the weighing procedure survives, but in all likelihood the babies were weighed unclothed (or were weighed with a blanket, the weight of which was subtracted).[13] As appears to have been typical of hospitals during the period, the weights were reported to the quarter-pound, but heaping alone would not bias the mean.

The strongest argument against measurement error is that birthweights were similarly high at lying-in hospitals in other cities. According to data collected by Storer (1850), the mean birthweight at Boston's Lying-In Hospital in the late 1840s was 3,368 grams. Mean birthweights at a lying-in hospital in Montreal during the second half of the nineteenth century ranged from 3,200 to 3,600 grams, depending on the decade (Ward and Ward, 1984). Although the evidence is admittedly fragmentary, it seems doubtful that systematic measurement error is

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[12] If the 1860s are excluded the mean birthweight rises to 3,466 grams. The mean birthweight during the 1860s was 3,336 grams.

[13] Several stillbirths weighing under a pound were recorded, which would not be credible if they included the weight of a blanket. A photograph appearing in Cone (1961, p. 496) suggests the typical practice in late eighteenth century Europe was to weigh babies naked.

responsible for the relatively higher birthweights of Almshouse infants.

The exclusion of sickly infants who were not weighed could bias the mean birthweight upward. These babies were often stillborn or dead shortly after birth. Judging by their mortality experience, which was far worse than average, the average birthweight of babies who were not weighed must have been between 1,000 and 2,000 grams. Approximately 4 percent of all infants were not weighed. If each weighed 1,000 grams (the lower bound), the overall mean birthweight would fall from 3,377 to 3,243 grams. The adjustment, while not trivial, leaves the substantive finding of relatively high birthweight unaffected.

This leaves a third possibility -- prenatal care during the third trimester may have raised birthweights at the Almshouse above levels outside the hospital. Modern studies in less-developed countries demonstrate that food supplements and reductions in work effort late in pregnancy result in increased birthweights (Lechtig, et al., 1975; Naeye and Peters, 1982). As pointed out previously, some mothers would have been brought to the Almshouse weeks before delivery, and they may have benefited from lessened physical labor and a more nutritious diet than that obtainable outside the Almshouse.[14]

We have examined the effect of prenatal care by calculating the mother's length of stay at the Almshouse prior to giving birth. Although there is no information on the date of admittance in the obstetrics records, we were able to link the names of those giving birth to other Almshouse records to obtain the

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[14] For a similar argument in the case of Boston, see Vogel (1980). According to Ashby's (1915) study of early twentieth century England, pregnant women who entered lying-in hospitals during their last trimester had infants whose birthweights were 300 grams higher than did mothers who entered such hospitals just prior to giving birth.

length of stay prior to birth for the year 1854.[15] The average length of stay was 46 days. Only a tenth entered within three days of giving birth. Twenty-five percent spent at least two months and a tenth spent the entire last trimester at the Almshouse.

A regression of birthweights in the linked (1854) sample indicates that women who spent at least one month at the Almshouse prior to delivery gave birth to infants who were 115 grams heavier than average.[16] The effect of prenatal care was imprecisely estimated, however, because the 95 percent confidence interval around the coefficient is [-50 grams, 280 grams]. The mean birthweight in 1854 is 3,450 grams. Subtracting the estimated effect of prenatal care (115 grams) produces an adjusted mean of 3,335 grams. Subtracting the upper bound of the confidence interval reduces the mean further to 3,170 grams, or approximately eight percent below the unadjusted mean. The ameliorative impact of the Almshouse suggests that at least some of Philadelphia's poor received considerably better care within the confines of the poorhouse than outside it.[17]

Accounting for the two downward adjustments, average birthweights among the urban poor ranged between 2,900 and 3,200 grams around 1850 to 1870, or about 8

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[15] Length of stay was derived by linking the obstetrics records to the "Almshouse Hospital Female Register, 1803-1887" (record series 35.116, Archives of the City and County of Philadelphia). The register records admittances on a daily basis. The obstetrics records give the name of the mother and the date of birth of the infant. To perform the linkage it was necessary to search the register for the name of the mother for all days previous to the date of birth. Because this procedure proved to be extremely costly, we were able to perform the linkage for only a single year. The year 1854 was chosen because the number of births was relatively high.

[16] In his study of birthweights in Vienna in the late nineteenth and early twentieth centuries, Ward (1986, p. 10) found that length of stay raised birthweight by 4.1 grams per day, which translates into 123 grams a month, quite close to our estimate.

[17] See Katz (1986) for a discussion of the shift from indoor to outdoor relief in America and the assault on the poorhouse by reformers.

to 10 percent below the average birthweight of Almshouse infants. A mean birthweight from 2,900 and 3,200 falls between the 10th and the 25th centile of a modern birthweight distribution (see Tanner, 1978), which is consistent with the evidence presented above on the short adult stature of the urban poor and roughly equivalent to levels in many less-developed countries today.[18]

Thus the urban poor began life at a nutritional disadvantage. In modern data, factors associated with reduced birthweight include maternal malnutrition, maternal or fetal infections, heavy physical labor during pregnancy, alcohol consumption, ingestion of toxic substances, and a genetic predisposition to low birthweight (Stein, et al., 1975; Hurley, 1980; Naeye and Peters, 1982; Tanner, 1978; Hytten and Leitch, 1971). Except for genetic predisposition, it is likely that all other factors mattered among the urban poor, although their relative importance cannot be deduced from the available evidence.[19] That the mothers of the urban poor would have been poorly nourished by modern standards and subject to a variety of infections, seems impossible to doubt, given their general poverty and poor environmental conditions. Labor force participation rates among foreign-born and single women were high (Dublin, 1979; Goldin and Sokoloff, 1982;

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[18] For example, a mean birthweight falling between 3,000 and 3,100 grams would be close to levels observed in Mexico and Thailand in the mid-1950s (Meridith, 1970 ,p. 232). The estimated range is also similar to the range of birthweights recorded at lying-in hospitals in nineteenth-century Europe; see Tanner (1981).

[19] Genetic factors may be ruled out because it is doubtful that genetic differences among the urban poor were large, given the populations from which they were drawn. Short maternal stature, however, may account for some of the reduced birthweight. According to Hytten and Leitch (1971, p. 308) birthweight declines by about 20 grams per inch of mother's height. Although we have no information on the adult heights of urban women during the period, adult female slaves were about 1.5 inches below modern standards (Steckel, 1986a). Since it is doubtful that urban women differed significantly in stature from adult female slaves (a conclusion suggested by the evidence on adult male heights), short maternal stature could explain at most 12 percent (30/250) of reduced birthweights among the urban poor.

Stansell, 1986), and there is little evidence that poor women reduced physical labor during pregnancy. The level of alcohol consumption during the period was high enough to suggest that its negative effects on birthweights were substantial.[20]

Our results indicate that birthweights fell sharply during the Civil War decade, and it is unlikely that the biases discussed above are responsible for the decline.[21] A widely used benchmark for judging declines in average birthweight is that observed during the Dutch famine of World War II. Due to a sharp reduction in caloric intake, birthweights in the central part of Holland in 1944 fell about 300 grams below the normal level (Stein, et al., 1975). By the standards of the Dutch famine experience the decline in birthweight at the Almshouse -- 299 grams comparing the trough in 1866 to the average weight during the 1850s -- was severe.

Previous studies have documented a decline in real wages during the Civil War years and stagnant economic growth over the decade as a whole (Mitchell, 1903; Lebergott, 1964; Engerman, 1966). A time series regression of average birthweight

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[20] According to Abel (1982) daily consumption of more than 2 ounces of absolute alcohol by pregnant women is associated with a significantly increased risk of Fetal Alcohol Syndrome and reduced birthweight. Rorabaugh's (1979) estimates of absolute alcohol consumption during the late antebellum period are close to or exceed this figure and, as he points out, there is no evidence that women were generally more temperate than men.

[21] It might be argued that the decline in birthweight during the Civil War, and the absence of an upward trend in birthweight over the whole period, may be misleading for the urban poor as a whole. The number of births at the hospital was roughly constant from year to year (except during the Civil War, when the number of births fell). If the population from which Almshouse mothers were drawn was increasing in size over time, the Almshouse admittance policy may have produced a group of mothers that was increasingly impoverished over time, especially during the Civil War. This tendency would be offset, however, by increases over time in the real incomes of the urban poor. Unfortunately, a direct examination of the hypothesis is not possible, because we lack detailed information on the socioeconomic background of the mothers.

(1860 to 1873) on a distributed lag in the real wage and a time trend yields an elasticity of mean birthweight with respect to the real wage of 0.2, and a positive coefficient on the time trend.[22] Since the trend in birthweight, unadjusted for the decline in real wages, was negative, it appears that the decline in real wages was the major factor behind the decline in birthweight.[23]

Our findings have implications for comparisons that have been made between living standards of the urban poor and of slaves. According to Steckel (1986a), the average birthweight of slave infants around 1850 was about 2,300 grams. Judging from our estimates the urban poor were far healthier at birth than were slave infants. But the mean adult heights of the two groups were the same (Margo and Steckel, 1983). Consequently, patterns of physical growth during childhood and early adolescence must have differed markedly between slaves and the urban poor, which supports Steckel's (1986a, 1986b) contention that the factors producing the extraordinary rate of catch-up growth were unique to the slave population.[24]

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[22] Based on preliminary runs, the lag was set at two periods. Thus the independent variables are: the current real wage, the real wage lagged once, the real wage lagged twice, and a time trend. The purpose of including a distributed lag in the real wage is to allow for the possibility that the nutritional status of the mothers might not respond immediately to the decline in the real wage. The real wage refers to unskilled labor and was taken from Lebergott (1964). There is some evidence (Mitchell, 1903, p. 302) that female wages declined relative to male wages during the early years; if so, use of the Lebergott series (which refers to males) may understate the importance of the real wage in explaining the decline in birthweight.

[23] An increase in the labor force participation of women might also be responsible for some of the fall in birthweight. According to Engerman (1966), however, the evidence for an increase in labor force participation is ambiguous.

[24] In particular, Steckel (1986b) argues that the improvement in the slave diet was timed with entry into the labor force in early adolescence. The improvement was sufficient to generate a rate of catch-up growth higher than any observed in modern populations.

3. Infant Mortality at the Almshouse

The Almshouse data suggest that birthweights among the urban poor were below modern standards. In modern data, reduced birthweight is associated with higher levels of neonatal mortality. The mortality experience of Almshouse infants, however, was far worse than that predicted by a modern schedule of mortality by birthweight.

Death rates by gestational age and birthweight are presented in Tables 3 and 4. Information is only available on fetal deaths (called "stillbirths" in the records) and first day deaths (deaths during delivery or shortly after birth). Because the distinction between fetal and first day deaths was not always clearly made, Table 4 nets out fetal deaths.

Overall, the death rate (fetal plus first day) was 82.6 per 1000 births. The overall first-day death rate was 25.3 per 1000 live births.[25] The death rate fell with gestational age and was U-shaped with respect to birthweight. Below 2,500 grams and above 4,000 grams the death rate increased sharply. The relative effects of gestational age and birthweight were smallest among low birthweight infants. These patterns are consistent with those displayed by modern schedules of mortality by birthweight (Shapiro, et al., 1965; Tanner, 1978).

In 1960 the fetal death rate in the United States was 16.1 per 1000 births. First-day deaths were 14.8 per 1000 live births in 1935 and 9.3 per 1000 live births in 1964 (Shapiro, et al., 1965). The higher rate of fetal loss at the Almshouse may not be too surprising: some of the mothers attempted to abort

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[25] The calculations (and the figures in Tables 3 and 4) exclude mothers diagnosed as venereal, because their infants experienced much worse mortality than the average, even holding constant birthweight (see Table 5). If such mothers were included the death rate (fetal plus first day) would rise to 88.7 per 1000 births, and the first day death rate would rise to 29.2 per 1000 live births.

through physical means or the use of chemical abortifacients.[26] But the first-day death rate and the implied neonatal death rate are also higher, especially among infants weighing under 2,500 grams. In 1950 the neonatal death rate under 2,500 grams was 173.1 per 1000 live births, and the neonatal death rate was twice the first day death rate (Shapiro, et al., 1965, pp. 271, 318).[27] Our estimate of the first-day death rate for babies under 2,500 grams is 125.8 per 1000 live births. Doubling the figure gives an estimate of the neonatal death rate of 251.6 per 1000 live births, 45 percent higher than the figure in 1950. Furthermore, it is likely our estimate is biased downward, because the ratio of the neonatal death rate to the first-day death rate declined over time (Shapiro, et al., 1965, p. 271).

Further analysis of the determinants of fetal and first day deaths in Table 5 supports the reliability of the mortality data, and also reveals how the conditions surrounding the birth influenced the chances of infant death. Column (1) reports a logistic regression of the probability of a fetal or first- day death, and column (2) reports a regression of first day deaths. Because of the overwhelming importance of gestational age, the sample includes only observations for which gestational age was available.

Prematurity and low birthweight were by far the most important determinants

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[26] The conclusion is suggested by marginal notes in the obstetrics records. An alternative explanation of the high fetal death rate stresses the effects of dietary supplements in late pregnancy given to otherwise malnourished mothers; in such cases the fetal death rate (in late pregnancy) may be higher than it would be otherwise (see Keilmann, et al., 1983).

[27] The ratio of the neonatal and first day death rates was calculated by averaging over all birthweights. It is unclear from the medical literature whether the probability of a first day death (relative to the probability of a neonatal death) is higher for babies under 2,500 grams. If the relative probability were higher, our estimate of the neonatal death rate under 2,500 grams would be biased upwards.

of infant mortality, and the signs of the coefficients mimic the patterns in Tables 3 and 4. The probability of a fetal death increased with the age of the mother, while the probability of a first-day death decreased with her age, patterns found in modern data.[28] Babies born to mothers diagnosed as venereal had higher death rates, even after controlling for lower average birthweight.[29]

As in the analysis of birthweight, one might expect married women or widows to be better-off economically, and their infants to have a lower risk of dying. Although the effects of marital status have the correct sign (negative), the coefficients are statistically insignificant. Somewhat surprisingly, the child's sex was unrelated to mortality.[30] The season and year of birth also had no effect on the probability of infant death.[31] Compared with other ethnic groups, Irish babies faced a greater risk of dying, although the difference was small relative to other factors.[32]

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[28] Shapiro, et al. (1965, pp. 320-21) show that the fetal death rate increases with the age of the mother beyond age 20, and that the neonatal death rate has an inverted U-shape with respect to mother's age. The inverted U-pattern is consistent with the signs of the age and age squared coefficients in the regression of first-day deaths. The coefficient on parity in the regression of first-day deaths is also consistent with modern data, which shows a strong positive relationship between parity and infant mortality, particularly for women under age 25 (the majority of Almshouse mothers); see Shapiro, et al. (1965, ibid.)

[29] The result presumably reflects the transmission of venereal disease from the mother to the fetus.

[30] The result is puzzling, because in modern data males have higher fetal and perinatal death rates than females, although the differences are small; see Shapiro, et al. (1965, p. 311).

[31] The infant death rate, not controlling for other factors, was 25 percent higher in the 1860s than in the 1850s. Thus the insignificant coefficients on the year of birth dummies imply that the factors controlled for in the regression--in particular, birthweight--account for the rise in mortality during the Civil War decade.

[32] One explanation of the higher mortality among Irish infants concerns religion. A majority of Irish mothers were unwed, and presumably the vast majority were Roman Catholic. If the social consequences of illegitimacy were

The conditions surrounding the birth greatly affected the probability of infant death. Other things equal, a lengthy labor was associated with higher mortality, as was the use of forceps. The results suggest that the poor quality of nineteenth-century obstetrics practice may have been an important reason for the high first-day death rate. According to Shorter (1981; see also Leavitt, 1986) intervention during delivery was discouraged, and the preferred regimen was to let nature run her course. In lengthy or difficult deliveries forceps were used, but the emphasis was on saving the mother, not the infant. The Almshouse data suggest that, had the attending physician been able to monitor fetal health more closely during labor and had he the willingness (and ability) to intervene earlier and more successfully, the first-day death rate would have been significantly lower.[33]

Previous studies of birthweights and infant mortality in the nineteenth century have applied modern schedules of mortality by birthweight to estimated birthweight distributions to generate estimates of neonatal mortality (Steckel, 1986; Fogel, 1987).[34] In modern data, most neonatal mortality is accounted for

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worse in Irish neighborhoods, unwed Irish mothers may have tried to induce abortions more often than other mothers, or engage in other activities (for example, hide the pregnancy from relatives, and have little or no prenatal care) leading to a higher probability of an infant death. Alternatively, and perhaps more likely, the effect may be due to ethnic differences in socioeconomic status, the disease environment, female labor force participation, or the length of stay in the Almshouse prior to giving birth (see footnote 15). Unfortunately, the latter possibility -- differences in the length of stay -- cannot be investigated because the linked sample is too small to analyze mortality.

[33] Because most babies in the nineteenth century were delivered by midwives, and midwives used forceps infrequently, the forceps explanation may be relevant only for hospital births. Midwives, however, also followed the non-intervention regimen, which by itself increased the frequency of first-day deaths.

[34] For example, Steckel (1986a) estimated slave neonatal mortality in a four stage procedure. He first estimated a regression of height at ages 3 and 4 on birthweight, using modern data. Next, he used the regression coefficients to predict the mean birthweight of slave infants, given slave heights at ages 3

by those under 2,500 grams at birth, and the death rate under 2,500 grams varies little across countries, developed or underdeveloped (Fogel, 1987, p. 477). Our results suggest, however, that the mortality schedule by birthweight has not been stable over time. Infant death rates under 2,500 grams were considerably higher in the nineteenth century than they are today. It follows that estimates of infant mortality derived from applying modern mortality schedules to historical birthweight distributions are biased downward.[35]

4. Conclusion

The social history of the urban poor in mid-nineteenth century America is a history of deprivation. We have presented evidence on one important aspect of urban poverty and its consequences -- birthweights and infant mortality -- using evidence derived from the obstetrics case records of Philadelphia's Almshouse hospital. Adjusting for various biases, it appears that the children of the urban poor weighed between 2,900 and 3,200 grams at birth, or 250 to 550 grams below modern standards. Birthweights declined during the Civil War decade, consistent with the poor state of the economy in the 1860s. Because birthweights were lower than modern standards, the urban poor suffered higher levels of infant mortality than today. But infant mortality was considerably worse than that expected from a modern schedule of mortality by birthweight, and a major determinant of the

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and 4, which were derived from the slave manifests. He then chose a modern distribution of birthweight whose mean mostly closely corresponded to the estimated mean birthweight of slave infants. The final step was to apply a modern schedule of mortality by birthweight to the estimated distribution of slave birthweights.

[35] It also follows that such a procedure may incorrectly estimate the proportion of decline over time in neonatal mortality due to increasing birthweight, and will also miss the interaction effect between shifts in birthweight and shifts in the birthweight-mortality schedule.

excess mortality appears to have been the poor quality of nineteenth-century obstetrics. By the mid-twentieth century hospital births were common occurrences, average birthweights in the United States were higher than those observed in our sample, and the birthweight-mortality schedule had shifted downward (Shorter, 1981; Leavitt, 1986; Shapiro, et al., 1965). It is not yet clear when birthweights began to rise and whether improvements in obstetrical practice were responsible for the shift in the birthweight-mortality schedule.[36]

In sum, birthweights of the urban poor in nineteenth-century America are consistent with evidence on their terminal heights. They were born into the 25th centile by modern standards and died in approximately the same condition. Their birthweights, however, can explain only a small portion of their high infant mortality. Birthweights did not decline during mid-century as has been hypothesized, but they did respond severely to the deprivation and dislocation wrought by the American Civil War.

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[36] Leavitt (1986), for example, argues that while infant mortality was lowered by the shift of births from home to hospital, maternal mortality was, at least in the short run, increased.

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Table 1

Sample Statistics: Almshouse Mothers, 1848-1873

Variable	Percent (× 100)
Age of Mother:	
< 20	17.1 %
20-25	48.9
26-30	21.7
31-35	8.1
> 35	4.2
Parity (number of previous children):	
0	60.3
1	20.6
2	7.7
3	3.9
> 3	7.5
Marital Status:	
Married	38.2
Widow	4.0
Single	57.8
Mother's place of birth:	
Philadelphia	17.0
Other U.S.	13.6
Irish	50.7
English	3.7
German	13.5
Other foreign	1.5
Number of observations	4,841

Source: See text

Table 2

Determinants of Birthweight, 1848-1873

Variable	β	t-stat	β	t-stat
Constant	-2972.36	3.46	3029.56	18.01
Characteristics of Mother:				
Age in years $\times 10^{-1}$	101.84	0.75	200.44	1.52
Age^2	-17.75	0.72	-35.18	1.45
Parity	110.62	5.59	83.57	4.50
Parity^2	-10.76	4.76	-7.60	3.72
Married	-11.07	0.51	-0.20	0.01
Widow	24.01	0.50	48.75	1.03
Venereal	-249.68	3.35	-680.74	8.36
Alcoholic	-485.88	2.24	-1258.51	5.26
Place of Birth:				
Philadelphia	-152.35	5.86	-200.04	7.71
Other U.S.	-93.45	3.27	-119.99	4.24
Germany	-104.35	3.52	-147.37	5.36
England	-126.51	2.61	-172.63	3.73
Other Foreign	-63.99	1.25	-42.01	0.84
Characteristics of Child:				
Male	96.39	5.31	104.31	6.00
Twins	-900.84	13.55	-887.69	16.05
Gestational Age	2481.51	3.52		
Gestation^2	-102.13	0.70		
Season of birth:				
Spring	25.62	0.98	44.59	1.80
Summer	8.47	0.34	0.72	0.03
Fall	25.65	0.99	19.80	0.81
Year of Birth:				
≥ 1855	48.35	0.87	77.00	2.45
1856-60	146.07	4.89	135.64	4.13
1861-65	24.75	0.82	10.91	0.32
1866-70	-89.46	3.11	-84.91	2.66
R^2	0.33		0.12	
N	3,249		4,390	

Notes: Dependent variable is measured in grams; sample excludes fetal deaths. Omitted place-of-birth dummy is "Irish"; omitted year of birth is "1871-73." Parity is number of children (including current birth). Gestational age is measured in (days $\times 10^{-2}$). Time = (Year of Birth - 1848).

Table 3

First Day and Fetal Deaths per 1000 Births:
By Birth Weight and Gestational Age

Weight	Gestational Age: Pre-Term		Full-Term		Unknown	
Unknown:	757.1	(70)	611.1	(36)	262.2	(99)
≤ 1000 grams	812.5	(16)	0.0	(1)	500.0	(2)
1001-1500	702.7	(37)	571.4	(7)	666.7	(9)
1501-2000	463.4	(41)	314.3	(35)	266.7	(15)
2001-2500	333.3	(60)	121.2	(132)	79.4	(63)
2501-3000	156.3	(32)	53.5	(430)	34.2	(146)
3001-3500	105.3	(19)	43.3	(1015)	24.2	(372)
3501-4000	0.0	(6)	35.2	(1079)	34.4	(436)
4001-4500	-	(0)	42.1	(404)	30.6	(163)
≥ 4501	-	(0)	79.5	(88)	71.4	(28)
≤ 2500 grams	506.5	(154)	177.1	(175)	179.8	(89
≥ 2501 grams	122.8	(57)	42.8	(3016)	31.4	(1145)
Total:	491.1	(281)	57.0	(3227)	60.0	(1333)

Overall: 82.6 per 1000 births (N = 4841)

Notes: Sample excludes venereal mothers. Sample sizes in parentheses. Pre-term: 36 weeks or less; Full-Term: over 36 weeks

Table 4

First Day Deaths per 1000 Births:
By Birthweight and Gestational Age

Weight	Gestational Age: Pre-Term		Full-Term		Unknown	
Unknown	451.6	(31)	333.3	(21)	51.9	(77)
≤ 1000 grams	500.0	(6)	0.0	(1)	0.0	(1)
1001-1500	476.2	(21)	400.0	(5)	571.4	(7)
1501-2000	241.4	(29)	76.9	(26)	83.3	(12)
2001-2500	111.1	(45)	41.3	(121)	49.2	(61)
2501-3000	35.7	(28)	14.5	(413)	7.0	(142)
3001-3500	0.0	(17)	8.2	(979)	2.7	(364)
3501-4000	0.0	(6)	13.2	(1055)	7.1	(424)
4001-4500	-	(0)	20.3	(395)	18.6	(101)
≥ 4501	-	(0)	24.1	(83)	37.0	(27)
≤ 2500 grams	247.5	(101)	59.8	(153)	98.8	(81)
≥ 2501 grams	19.6	(51)	13.0	(2925)	8.0	(1118)
Total	218.6	(183)	17.5	(3099)	16.4	(1276)

Overall 25.3 per 1,000 live births (N = 4558)

Sample excludes venereal mothers and fetal deaths. Sample sizes in parentheses.
Pre-Term: 36 weeks or less; Full-term: over 36 weeks.

Table 5

Logistic Regressions of Infant Mortality: Philadelphia's Almshouse, 1848-1873

	(1) First Day + Fetal		(2) First Day Only	
Variable	β	t-stat	β	t-stat
Constant	-2.58	1.36	0.68	0.20
Characteristics of Mother:				
$Age_2 \times 10^{-2}$	2.50	2.08	-1.91	1.08
Age^2	-0.39	1.79	0.31	0.99
$Parity_2$	0.04	0.26	0.87	2.46
$Parity^2$	0.001	0.06	-0.09	1.89
Married	-0.32	1.62	-0.37	1.14
Widow	-0.08	0.20	-0.74	0.94
Venereal	0.64	1.76	1.27	2.58
Alcoholic	0.006	0.004	1.03	0.76
Place of Birth:				
Philadelphia	-0.29	1.29	-0.75	1.79
Other U.S.	-0.85	2.91	-0.89	1.88
German	-0.62	2.30	-0.19	0.45
English	-0.57	1.23	-0.68	0.85
Other Foreign	0.19	0.52	1.68	1.47
Characteristics of Child:				
Gestation	-1.63	4.34	-1.38	2.46
Male	-0.10	0.61	-0.07	0.24
Twins	0.04	0.10	0.03	0.22
Weight in grams:				
≤ 1500	3.12	7.31	3.66	5.52
1501-2500	1.79	7.87	1.99	5.08
≥ 4001	0.09	0.37	0.28	0.64
Unknown	3.70	9.99	3.66	6.21
Characteristics of Delivery:				
Length of labor hours $\times 10^{-1}$	0.17	3.26	0.24	3.29
Forceps used	1.92	7.39	2.43	6.15
Season of Birth:				
Spring	0.19	0.84	0.66	1.75
Summer	0.06	0.28	-0.07	0.17
Fall	-0.09	0.41	-0.07	0.17
Year of Birth:				
≤ 1855	-0.14	0.26	-0.28	0.30
1856-60	0.26	0.94	0.44	0.98
1861-66	-0.08	0.32	-0.49	1.05
1866-70	0.15	0.60	-0.16	0.37

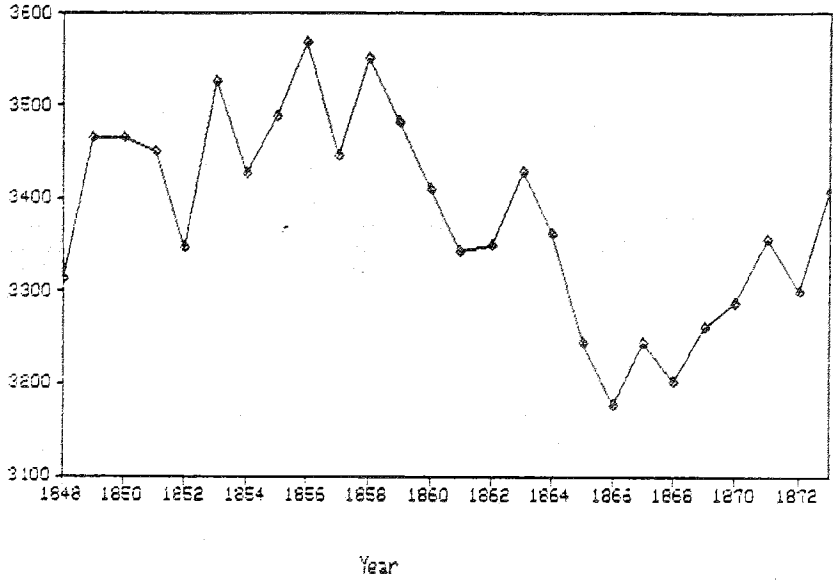
Table 5
(continued)

	(1)	(2)
N	3,074	2,888
-2 × log likelihood ratio	1,258.6	486.6
Mean Value of the dependent variable	0.087	0.028

Notes: Left-out place of birth dummy is "Irish"; left-out weight dummy is "2501-4000"; left-out year of birth dummy is "1871-73." Observations with missing gestation or length of labor are excluded. Other Foreign: all foreign other than Irish, English, and German. Time = Year of Birth - 1848.

Figure 1

The Trend in Birthweight: Almshouse Hospital, 1848-1873



NOTE: Sample includes all births for which weight was recorded.
SOURCE: see text