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ABSTRACT

I demonstrate that although socioeconomic differences in birth weight have always been fairly small in the United States, they have narrowed since the beginning of this century. I argue that maternal height, and therefore the mother's nutritional status during her growing years, accounted for most of the socioeconomic differences in birth weight in the past, but not today, implying that in the past health inequality was transmitted across generations. I also show that children born at the beginning of this century compared favorably to modern populations in terms of birth weights, but suffered higher fetal and neonatal death rates because obstetrical and medical knowledge was poorer. In addition, by day ten children in the past were at a disadvantage relative to children today because best practice resulted in insufficient feeding. The poor average health of past populations therefore originated in part in the first days of life.

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Evidence on long-term trends in social differences in health in the United States is sparse and often conflicting. In the nineteenth century, the relationship between wealth and survival rates seems to have been fairly egalitarian. Wealth conveyed no systematic advantage for survival of women and children matched in the 1850 and 1860 censuses (Steckel 1988; Davin 1993). Although Preston and Haines (1991) find that paternal occupation was an important correlate of child survival in the late nineteenth century, differentials by occupational class were fairly small. But, between 1900 and 1930 differentials in infant mortality by social class increased and then continued to increase throughout the latter half of this century (Ewbank and Preston 1990; Antonovsky and Bernstein 1977; Singh and Yu 1995). The mortality pattern for adults is less clear cut. Elo and Preston (1995) conclude that educational differences in adult mortality have widened since 1960 for men but contracted for working-age women.

Although differences in height and weight for height by social class have always been relatively small in the United States (particularly compared to Europe), differences in the past were larger than they are today. Among adults differentials in height by occupational group were especially small at the time of the American Revolution, but widened for those who served in the Civil War and then narrowed substantially only for cohorts born after 1935. Similarly, differentials in weight for height by occupational class were much wider in the latter half of the nineteenth century than over the last 30 years (Costa and Steckel 1997). The shift from a mortality regime in which infectious diseases equalized death to one in which chronic diseases predominate may partially account for the divergent trends in mortality and anthropometric measures. In addition, because mortality trends are often based upon infant or child mortality whereas height trends are based upon adult heights, occupational sorting may explain some of the divergence.

This paper examines differences in birth weight by parental income. Birth weight is an important indicator of health status at birth and is associated with significantly increased relative risk of death in the first days of life. This risk springs in part from the prematurity of many low

birth weight infants and in part from intrauterine growth retardation. Infants that are small for gestational age because of nutritional or other deficiencies do not catch up in growth with normal infants and tend to be at greater risk of health problems throughout their lives (Tanner 1978). Barker (1994;1992) argues that intrauterine growth retardation is associated with chronic disease at older ages, including cardiovascular disease and adult onset diabetes.

Despite the importance of birth weight, relatively little is known about trends in birth weight by social class in the United States. Ward (1993: 95) reports that there was no obvious pattern of differences in newborn weights in Boston at the end of the nineteenth century among major occupational groups, but he was only able to examine mother's occupation at a time when most women did not work. The 1931 edition of Williams' *Obstetrics* states that the larger size of children of well to do parents is in large part attributable to their mother's better health and nutrition. A pediatrics book of the 1930s reported that the mean weights at birth of children of poverty stricken parents in New York City were 50 grams less than those of children of parents of moderate income (Holt and Howland 1933), a relatively small difference. This paper investigates income differentials in birth weights among the children born at New York Lying-In between 1910 and 1931, comparing them with those today using the 1988 National Maternal and Infant Health Survey. It then investigates the implications of socioeconomic differences in birth weight by examining mortality and weight in the first ten days of life.

My findings have implications not just for the distribution of well-being, but also for explanations of changes in the average health of the population. Young adults born in the first decades of this century were in worse health than those born in the latter half of the century. They were shorter, lighter for any given height, and faced a greater mortality risk throughout their lives (Costa and Steckel 1997). By examining birth weight and the first days of life, I am able to determine if inadequate net nutrition, either in utero or in the first days of life, is a likely explanation for improving average health.

1 Producing Birth Weight

An important determinant of birth weight is maternal nutrition and health. Women with low prepregnancy weights and with inadequate pregnancy weight gain tend to have smaller babies. But, the relationship between maternal nutrition and fetal growth is nonlinear; deprivation must pass a threshold level before birth weight is significantly affected because the fetus is protected at the expense of the mother (Tanner 1978: 46). Infectious disease, alcohol or drug use, smoking, and heavy physical work also can reduce birth weight. The impact of these factors, particularly maternal diet, are felt most strongly in the third trimester, when fetal weight gain is greatest. Inadequate prenatal care will also reduce birth weight (Joyce 1994), but in the past prenatal care was certainly less effective and may even sometimes have been harmful.[1]

Other important determinants of birth weight are the factors that are specific to a pregnancy, such as the age of the mother, parity, the time interval between births, and the length of gestation. Birth weight rises at a decreasing rate with the age of the mother, parity, the spacing interval and gestational age. In addition, genetic factors matter. Taller mothers have larger babies, male newborns tend to be weigh about one hundred grams more than females, and multiple births are lighter than single births.

Income plays a role in the determination of birth weight either as an enabling variable, that is one which permits the purchase of better nutrition or medical care, or as a proxy for health

[1] In the first third of this century prenatal care was common only after the seventh month and consisted largely of instruction of the patient in diet, exercise, and hygiene; arrangements for confinement; desirability of nursing; the importance of regular medical exams to detect abnormalities, toxaemia, and eclampsia; and the danger signs of pregnancy (Speert 1980: 144). But, instructions on diet were often contradictory and sometimes harmful. Thus Fitzgibbon (1937: 62) writes, "She should be told, that, contrary to the commonly accepted precept, she should eat rather less than usual during pregnancy." In contrast, Shears (1928: 56) writes, "As regards the frequency of meals and the amount of food to be taken, the appetite of the patient is, within reasonable limits, the best guide. It is folly to refuse sufficient nourishment to a woman who must provide not only for her own necessities, but for those of her living and growing children... Schemes of reduction advocated in books written for the laity are to be regarded with suspicion." However, prenatal care probably did reduce maternal mortality.

habits such as smoking and appropriate exercise, for exposure to stress, or for maternal health endowments. Researchers who regress birth weight on income and omit these or other inputs will overestimate the impact of income. In fact, Rosenzweig and Wolpin (1991) argue that even if parental incomes were equalized, most at birth inequality would still remain.

Although parental income may partially proxy for unobservable maternal nutrition and health or for maternal health habits, it is still of interest to establish the long-term trend in birth weight by parental income. In addition, I will also examine whether once I control for all observerable factors such as mother's height, parity, and age, gestational age, and child's sex, differences in birth weight by income class persist. This will enable me to determine what some of the sources of birth weight inequality by income class are, but of course it cannot answer the question of what would happen to birth weight inequality if parental incomes were equalized.

2 The Records of New York Lying-In

New York Lying-In was a major force in Manhattan.[2] At the beginning of this century, American women increasingly began to entrust physicians to deliver their babies. In Manhattan, the proportion of births attended by physicians rose from 60 percent in 1910 to 74 percent in 1920 and to 93 percent in 1930. Approximately 10 percent of all physician attended confinements in Manhattan were treated by the obstetricians of New York Lying-In either in the hospital or in the patient's home.[3] Large numbers of the records of both the indoor and the outdoor departments from 1896 to 1931 have been preserved in the archives of New York Hospital, Cornell Medical

[2]Established in 1798, the Society of the Lying-In Hospital of the City of New York was at the end of the last century aiding women in confinements in their own homes. In 1892, the Society merged with the Midwifery Dispensary to form a hospital, thus enabling it to provide care both inside a hospital and in patients's homes. The work of the Society was not just medical, but also charitable and educational, providing information to patients and sometimes financial assistance.

[3]Estimated from successive annual reports of The Society of the Lying-In Hospital of the City of New York.

Center.[4]

In 1910, 60 percent of all births were outdoor, in 1920 39 percent, and in 1930 22 percent. The socio-economic characteristics of patients in both departments were similar, with no statistically significant differences in the husband's weekly wage. However, babies born in the indoor department had birth weights that were 400 grams lower than those of babies born in the outdoor department and their mothers had higher rates of maternal mortality. It was common practice for hospitals to bring abnormal or complicated cases into the hospital, even when they occurred in the outdoor service (Loudon 1992: 330).

Three equal sized samples of live births were drawn from the records of New York Lying-In between 1910 and 1931. The first consists of a sample of children who left the indoor department alive, the second a sample of children who left the outdoor department alive, and the third a sample of children in the indoor department who died in the first few days of life. Weights that will be used in estimating population means were constructed based upon the actual number of deaths and the number of indoor relative to outdoor births.

The clientele of New York Lying-In was largely upper working class, paying a fee determined by their income. No husbands listed a professional occupation. The average wage of husbands was about $20, an amount equal to the average weekly earnings of production workers in manufacturing (see Series 802-810 in US Bureau of the Census 1975: 170). The data suggest that prior to 1915, the clientele was somewhat more likely to consist of common laborers than of more skilled workmen.[5] The clientele was also largely foreign-born – 81 percent in 1910, 68 percent in 1920, and 52 percent in 1910. In contrast, in the city of New York and its boroughs,

[4]Not all records were preserved. Certain months, such as January, June, and December were more likely to be preserved.

[5]The coefficient of variation of the husband's weekly wage was smaller prior to 1915. The ratio of laborers to clerks was 5.5 to 1 in 1910 but by 1915 was 4.0 to 1 and by 1920 2.2 to 1.

only 52 percent of women aged 18 to 39 were foreign-born in 1910 and only 40 percent in 1920.[6] Relative to foreign born New York City women aged 18 to 39, the foreign-born clientele of the hospital was disproportionately Russian.[7]

The women patronizing New York Lying-In were predominately housewives. Less than 3 percent of them worked outside the home. Less than one percent had been abandoned by the child's father or had been widowed before the child's birth. The mean age of these women was 27 and their mean parity 1.6. Average gestational age was 39.7, as one might expect from a modern, white population. Relative to women today, these women were much smaller. The average height of women age 21 or older was 157 centimeters, and that of native-born women 160 centimeters. In contrast, the average height of mothers in a modern survey was 165 centimeters.[8]

The data from New York Lying-In will be compared with the 1988 National Maternal and Infant Health Survey. This survey is a random sample of 1988 births and contains both birth and death certificate and interview information. It oversamples low birth weight babies and all population means estimated from this survey are adjusted using the sampling weights. In order to ensure comparability with the New York Lying-In sample, the survey was restricted to white births to married mothers and tabulations will be presented both for this entire subsample and the subsample further restricted to women married to high school educated men.

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[6]Estimated from successive annual reports of the Society of the Lying-In Hospital of the City of New York and the 1910 and 1920 public use census samples (Ruggles and Sobek 1995).

[7]In 1910 52 percent of all foreign-born patients were Russian, 13 percent were Austrian, and 4 percent were Italian. The figures for New York City women aged 18 to 39 were 28 percent, 13 percent, and 15 percent, respectively. In 1920 48 percent of all patients were Russian, 12 percent Austrian, and 21 percent Italian. The figures for New York City women aged 18 to 39 were 26 percent, 12 percent, and 21 percent. (Society of the Lying-In of the City of New York, 1910, 1920; Ruggles and Sobek 1995). Contemporaries remarked that "the repugnance of the Italian mother to the presence of the physician in the lying-in chamber is well-high insuperable" (quoted in Loudon 1992: 306). Even in other cities, Russian Jews heavily patronized hospitals, such as Chicago Lying-In Hospital and Dispensary (Loudon 1992: 306).

[8]Estimated from the 1988 National Maternal and Infant Health Survey.

3 Birth Weight and Income

The birth weights of babies born under the attendance of the physicians of New York Lying-In compared favorably with modern populations (see Table 1). Mean weight at birth of singletons was 3460 grams and only 5.5 percent of babies weighed less than 2500 grams. In 1988, mean weight at birth of singletons born to white, married women was 3454 grams and 4.7 percent weighed less than 2500 grams. The mean birth weight of babies born to white, married non-smokers was 3508 grams and only 3.6 percent of babies weighed less than 2500 grams. It was not only the children born under the auspices of New York Lying-In who had high birth weights. Birth weights in Boston at the end of the nineteenth century and in the Philadelphia almshouse in the middle of the nineteenth century were relatively high by modern standards as well.

The babies born at New York Lying-In compared favorably not just with modern birth weight standards, but also with modern length and head circumference standards (see Table 2). They generally fell between the 50th and 75th percentile, suggesting that the children born at New York Lying-In did not manifest any other signs of obvious intrauterine growth retardation such as shortness for gestational age or a disproportionately larger head relative to body size.

Low birth weight babies who survive the birth process today may not have survived in the past. In the Philadelphia Almshouse the number of fetal deaths per 1000 births was 61 per thousand. At the end of the century the rate at Boston Lying-In was about 60 per thousand, above the city average (Ward 1993: 94). At New York Lying-In the rate was 64 per 1000, higher than the New York State average of 43 per thousand (*Vital Statistics, 1939*: 21). In contrast, fetal deaths today are only 18 per thousand (Series 109, US Bureau of the Census 1993: 81). In the Philadelphia Almshouse gestational age, birth weight, the duration of labor, and the use of forceps during delivery were statistically significant and important predictors of fetal death (Goldin and Margo 1989), implying that prior to the second half of the century obstetricians may not have

Table 1: Birth Weights of Whites (Live Births), US

Sample	Year	Mean	Median	$\leq$ 2500gm (%)
Philadelphia Almshouse (Goldin and Margo 1989)	1848-1873	3375	3453	8.1
Boston New England	1872-1900	3480		6.5
Boston Lying-In (indoors)	1886-1900	3330		6.9
Boston Lying-In (outdoors) (Ward 1993: 148-149)	1884-1900	3479		4.7
New York Lying-In (singletons) (this paper)	1910-1931	3463	3467	5.5
US	1950		3320	7.1
US	1960		3340	6.8
US	1970		3330	6.9
US	1980		3400	5.8
US (Vital Statistics, various issues)	1990		3410	5.7
US, singletons, mothers married	1988	3454	3459	4.4
and non-smokers (1988 National Maternal and Infant) Health Survey)	1988	3508	3515	3.6

Note. Because deaths and outdoor births are over-represented in the sample, the sample was reweighted to provide a population average of all births attended by the physicians of New York Lying-In. The estimates from the 1988 National Maternal and Infant Health Survey were weighted to be representative of the population.

Table 2: Birthweight, Length, and Head Circumference

	Percentiles		
	New York Lying-In 1910-1931	1976 US Standards	
	50th	50th	75th
Females			
Birth weight (gm)	3430	3230	3520
Length (cm)	51.0	49.0	51.0
Head circumference (cm)	34.5	34.3	34.8
Males			
Birth weight (gm)	3500	3270	3640
Length (cm)	51.0	50.5	51.8
Head circumference (cm)	35.0	34.8	35.6

Note. Because deaths and outdoor births are over-represented in the sample, the sample was reweighted to provide a population average of all births under the auspices of New York Lying-In. The 1976 US Standards are from Behrman and Vaughan (1983: 27).

been knowledgeable enough to deliver many low birth weight babies alive. In fact, data on births today suggest that willingness to intervene for fetal indications appears to virtually eliminate intrapartum stillbirth (Bottoms *et al.* 1997).

The wage distribution in the New York Lying-In sample and in the 1988 survey were very different. Because the New York Lying-In sample was primarily upper working class, the wage distribution was very narrow – the coefficient of variation of wage income was only 0.33. In contrast, the coefficient of variation of wage income in the 1988 survey was 0.88 for the entire sample and 0.56 for the sample restricted to women married to men whose highest degree was a high school diploma. Because the New York Lying-In sample excludes both the wealthiest and the very poorest individuals, any variation in birth weight in the sample most likely underestimates the variation in the entire population.

Despite the much narrower wage distribution in the New York Lying-In sample relative to the 1988 survey, the distribution of birth weights was wider in the New York Lying-In sample

Table 3: Birth Weight Difference (Grams) By Birth Weight Percentile, Among Babies of at Least 37 Weeks' Gestation, Born to White, Married Mothers

Birth weight Percentile Difference	New York Lying-In 1910-1931	1988 Survey by Husbands' Educational Level	
		High School Graduates	All
90th-10th	1375	1217	1191
90th-50th	745	638	624
50th-10th	630	579	567
75th-25th	880	652	642

Note. Both the New York Lying-In data and the 1988 National Maternal and Infant Health Survey are weighted.

than in the 1988 survey (see Table 3). The difference in birthweight between the 90th and the 10th decile was 1375 grams in the New York Lying-In data and 1191 in the entire 1988 survey. The distribution of birth weights is tighter in 1988 than in the New York Lying-In data because both of the tails of the New York Lying-In distribution were slightly wider.[9] As I will show later, because both tails of the birth weight distribution were wider in the New York Lying-In data, the babies of New York Lying-In faced a greater mortality risk than babies today.

Not only was dispersion in birth weights greater in the New York Lying-In data than in recent data, but the dispersion depended upon more upon the wage percentile. Table 4 presents results from a weighted (by population weights) regression of birth weight on the logarithm of the wage evaluated at different wages percentiles.[10] In the New York Lying-In sample, the difference in birth weights between the 10th and 90th wage percentiles was 118 grams. Because the median birth weight of the Philadephia Almshouse population was equal to the birth weight of those at the 10th percentile of the wage distribution at New York Lying-In, most likely the difference

[9]The difference between the 90th and 10th deciles in Goldin and Margo's (1992) Philadelphia Almshouse data restricted to married women with at least 37 weeks' gestation was identical to that in the New York Lying-In data.

[10]A regression was used for smoothing because of the small sample size of the New York Lying-In data.

Table 4: Birth Weight Differences (Grams) by Wage Percentiles, Among Babies of at Least 37 Weeks' Gestation, Born to White, Married Mothers

Wage Percentile Difference	New York Lying-In 1910-1931	1988 Survey by Husbands' Educational Level	
		High School Graduates	All
90th-10th	118	11	52
90th-50th	51	4	20
50th-10th	67	7	32
75th-25th	67	5	26

Note. The results are from a weighted regression of birth weight on the logarithm of wages evaluated at population percentiles of the wage distribution using the New York Lying-In data and the 1988 National Maternal and Infant Health Survey.

between the 10th and 90th wage percentile of the entire population was much larger. In contrast, the difference between the 10th and the 90th wage percentiles in the 1988 survey was 52 grams for the entire sample and 11 grams for the sample of women married to high school educated men.[11]

4 Interpreting Income Differentials

The previous section showed that differences in birth weights between the 90th and the 10th wage percentiles were twice as large at New York Lying-In as in a national sample and ten times as large as in the national sample restricted to be socioeconomically comparable to the New York Lying-In data. Although differences in birth weight by income class have always been relatively small, they were much larger in the past than they are today. This section examines why these income differentials existed. Children born to poorer parents may have lower birth weights because

[11]Differences by education are much larger than those by income. For example, babies born to women married to men with less than a high school education weigh 203 grams less than those born to women married to men with a postgraduate degree. However, wage differences are the most comparable across years.

maternal health endowments are poorer or because their mothers are younger and therefore also of lower parity.

I estimate the impact of income on birth weight controlling for observable genetic factors, maternal health, and factors specific to a pregnancy among babies born after at least 37 weeks' gestation.[12] That is, I regress birth weight on the logarithm of income, a dummy variable equal to one if the child was male, mother's height, maternal age, parity, and parity squared, the logarithm of gestational age in weeks, a dummy variable indicating whether the mother was foreign-born, and the year the child was born. Maternal height is both a genetic factor and a measure of the mother's net nutritional status during her growing years. The variables were chosen to be comparable across years. Obviously, some variables that should be included in the regression such as maternal smoking or the use of prenatal care are excluded. Assuming that these are positively correlated with income, this suggests that my estimates of the impact of income will partially reflect maternal health habits.[13] I am also assuming that maternal age and parity are exogenous, but if the family is maximizing utility over various goods and number of children given a child health production function then age and parity are choice variables and therefore potentially endogenous (Rosenzweig and Schultz 1982).[14] The regression results therefore cannot tell us what would happen if we were to increase an individual's income, but they can tell us what some of the sources of birth weight inequality by income class are.

Table 5 shows that when I control for other covariates, income does not have a statisti-

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[12]In the New York Lying-In data there is a positive relation between the wage and birth weight among babies born after at least 37 weeks of gestation, but a negative one among babies born before 37 weeks of gestation. Most likely, poorer women who went into premature labor may have delayed calling a physician or arriving at the hospital by ambulence and therefore may have had higher rates of stillbirth or simply never made it into the sample.

[13]Of course, if some of the omitted variables are negatively correlated with income then the true impact of income will be underestimated. For example, if harmful advice is given to pregnant women and higher income women are most likely to receive advice, then the impact of income on birth weight will be underestimated.

[14]Family planning variables or measures of demand for female labor are normally used as instruments, but I do not have this type of information.

cally significant impact on birth weight in either the New York Lying-In data or in the 1988 survey, suggesting that the covariates can explain a good part of birth weight inequality by income class. (Income was a statistically significant predictor of birth weight in 1910-1931 when I controlled for no other covariates.) However, the point estimates suggest that the impact of income in the New York Lying-In sample was larger than in the recent data. The impact of income was larger in both samples when maternal height was excluded from the regression, but in the 1988 survey the difference was negligible. In contrast, in the New York Lying-In sample the point estimate of income was almost twice as large when maternal height was excluded from the regression as when it was included, implying that in the past much of the impact of income on birth weight was due to maternal height. Table 6, which shows predicted birth weight at different wage percentiles for the specifications with and without maternal height, illustrates. When height is excluded from the specification, the difference between the 90th and the 10th wage percentile is 80 grams, but this difference falls to 42 grams once height is controlled for.

Most likely height differences, and therefore the mother's net nutritional status during her growing years, would account for most of the birth weight differentials by income in a national sample as well. Height differences by income in the New York Lying-In sample are somewhat less than differences by occupation observed among men (Costa and Steckel 1997), suggesting that differences among women may well have been larger in a national sample.

The inclusion of height in the regression affects not only the impact of income, but also of foreign birth. When height is excluded from the regressions foreign birth has a negative impact on birth weight, but in the New York Lying-In sample and in the national sample, the impact of foreign birth becomes positive (though still insignificant). The impact of foreign birth depended on ethnicity (though again the results were insignificant). Italian-born mothers had babies that were 137 grams lighter than the babies of the native-born whereas Russian and Austrian-born mothers had babies of about the same size as the native-born.

Table 5: Correlates of Birth Weight Among White Babies of at Least 37 Weeks' Gestational Age, New York Lying-In (1910-1931), and 1988 Survey

	New York Lying-In 1910-1931			1988 National Maternal and Infant Health Survey: Husbands High School Educated			1988 National Maternal and Infant Health Survey: All Educational Levels		
	Mean	Coefficient	Coefficient	Mean	Coefficient	Coefficient	Mean	Coefficient	Coefficient
Birth weight (grams)	3532			3458			3507		
Intercept		-9288.9	-12798.21		-4918.53‡	-6529.93‡		-5798.35‡	-7754.79‡
		(10672.61)	(11236.62)		(1648.20)	(1714.55)		(937.92)	(961.54)
Log(Husband's Wage)	3.74	110.99	59.03	9.87	-1.37	-.43	10.12	19.26	17.00
		(104.55)	(108.89)		(20.80)	(20.86)		(11.91)	(11.70)
Log(Gestational Weeks)	3.70	1966.45‡	1596.58‡	3.69	2205.53‡	2261.84‡	3.69	2394.23‡	2363.80‡
		(546.46)	(565.75)		(443.82)	(442.70)		(253.43)	(250.77)
Parity	1.68	125.57‡	127.31‡	2.23	72.61*	67.74*	2.29	83.72‡	79.48‡
		(29.48)	(31.14)		(41.25)	(40.69)		(22.96)	(22.39)
Parity Squared	6.51	-7.84‡	-6.30†	7.02	-5.28	-4.29	7.20	-6.47†	-5.44*
		(2.96)	(2.96)		(6.00)	(5.96)		(3.26)	(3.18)
Mother's Age	26.48	2.77	-0.96	25.93	2.14	3.31	27.44	3.17	2.81
		(6.33)	(6.98)		(4.57)	(4.49)		(2.39)	(2.81)
Yearborn	1921	2.51	4.43						
		(5.43)	(5.70)						
Dummy=1 if mother foreign-born	0.69	-28.56	14.12	0.06	-123.49†	-89.53	0.09	-44.78	2.77
		(65.60)	(71.26)		(56.05)	(55.84)		(44.78)	(32.64)
Mother's height (cm)	157.54		9.13†	164.20		8.29‡	164.43		12.74‡
			(3.84)			(2.43)			(1.48)
Dummy=1 if child male	0.55	164.83‡	200.33‡	0.54	160.66‡	164.78‡	0.52	121.43‡	126.74‡
		(54.63)	(56.39)		(37.05)	(36.77)		(20.27)	(19.85)
Observations		380	348	785	785	785	2638	2638	2638
R^2		0.17	0.17		0.09	0.09		0.07	0.11

Note. All regressions and sample means are weighted. All wages in the New York Lying-In sample were converted to 1967 constant dollars. Robust standard errors are in parentheses. The symbols $*$, †, and ‡ indicate that the coefficient is significantly different from 0 at at least the 10 percent, 5 percent, and 1 percent level, respectively.

Table 6: Predicted Birth Weights Differences By Wage Percentiles, Holding Observable Characteristics Constant

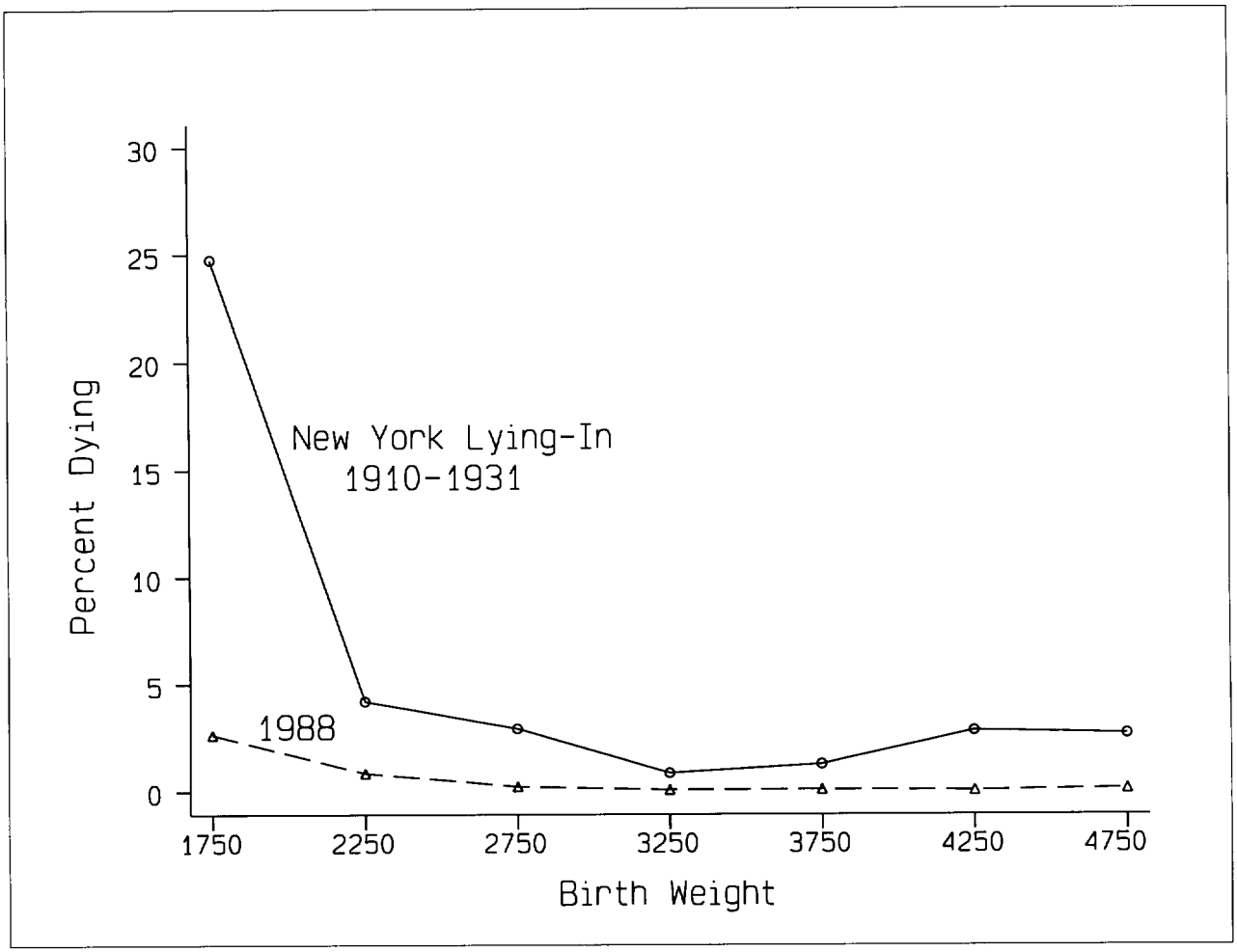
	New York Lying-In 1910-1931		1988 Survey Husbands' Education			
			High School		All	
	Regression Includes Maternal Height		Regression Includes Maternal Height		Regression Includes Maternal Height	
Wage Percentile	no	yes	no	yes	no	yes
90th-10th	80	42	-2	0	35	31
90th-50th	35	19	-1	0	12	12
50th-10th	45	23	-1	0	23	19
75th-25th	45	24	-1	0	17	15

Note. Birth weights were predicted using the regressions in Table 5.

5 First Days of Life

Although the babies of New York Lying-In compared favorably to modern populations, they faced an increased risk of death in the first ten days of life relative to similar sized babies today. This risk was particularly acute for low birth weight babies and therefore for the children of poorer individuals. Figure 1 illustrates. Twenty-five percent of the babies who weighed 1500 to 1999 grams in the New York Lying-In sample died by day ten, whereas in 1988 less than 3 percent did. In 1988 even babies who weighed only 500 to 1000 grams faced a lower risk of death (20 percent) than the smallest New York Lying-In babies. Risk of death falls in the New York Lying-In sample to reach a minimum at 3000 to 3499 grams and then rises somewhat at 4000 to 4499 grams. In 1988 the minimum mortality risk is at 4000 to 4499 grams and begins to rise slightly after 4500 grams. The relationship between the probability of dying and birth weight persists even controlling for the socioeconomic and demographic characteristics of the mother. Although income was not a significant predictor of mortality, the point estimate of income suggests that the children of the poor faced a greater mortality risk even controlling for birth weight.

Figure 1: Percentage of Children of 37 Weeks or More Gestation Dying Within Ten Days of Birth by Birth Weight, New York Lying-In (1910-1931) and 1988 National Maternal and Infant Health Survey



Note. Estimates from both the New York Lying-In sample and the 1988 National Maternal and Infant Health Survey are weighted. The weight intervals are centered at the marks and are 1500 to 1999 grams, 2000 to 2499 grams, 2500 to 2999 grams, 3000 to 3499 grams, 3500 to 3999 grams, 4000 to 4499 grams, and 4500 grams and over. There were no babies of 37 weeks or more gestation who weighed less than 1500 grams in the New York Lying-In sample.

Figure 2 compares the risk of death in the first ten days of life for children of all gestational ages across the New York Lying-In sample, a national 1950 sample, and the 1988 survey. It implies that the survival prospects of children weighing 1500 grams or less did not improve until after 1950, but that the survival prospects of children weighing 1501 to 2500 grams and more than 4500 grams did improve before 1950.[15] When I modeled the probability of dying as function of birth weight, the duration of labor, whether a nonspontaneous method of delivery, such as forceps, was used, and control variables such as the wage, gestational age, year of birth, whether the mother was foreign born, and the mother's age, parity, and height, I found that children whose mothers underwent longer labor had a greater (but still relatively small) probability of dying as did children delivered with a nonspontaneous method, both among babies of 37 weeks gestation or more and among all babies.[16]

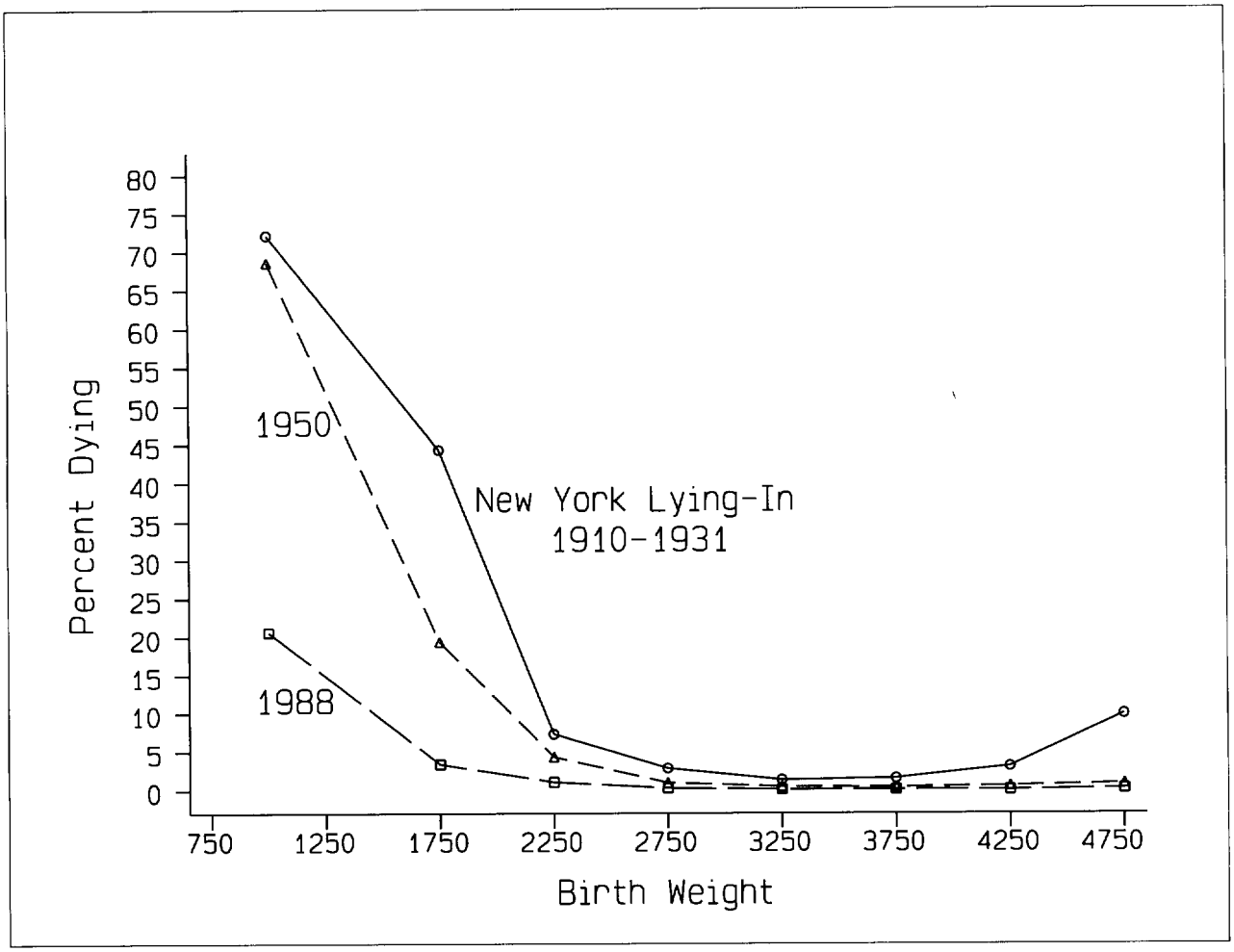
The cause of death pattern in the first days of life suggests that increasing obstetrical knowledge was a major factor in improving outcomes (see Tables 7 and 8). One fifth of the babies of all gestational ages born at New York Lying-In and one third of those of at least 37 weeks gestation died of birth injuries, often a cerebral hemorrhage.[17] Babies dying from both atelectasis and hemorrhage may also have been injured at birth. Mention of hemorrhage was more common among higher birth weight babies and could therefore have arisen because the fetal head was large in proportion to the size of the mother's pelvic outlet. Birth injuries could also have arisen from prolonged labor or injudicious mechanical interference with delivery and therefore may equalized deaths across income classes. Birth injury remained a major cause of death in 1950, but by 1988

[15]Although I cannot determine how long babies born in the Philadelphia Almshouse were observed and therefore whether low birth weight babies in the 1920s fared better than their mid-nineteenth century counterparts, the Almshouse data suggest that a birth weight of 3000 to 3499 grams minimized mortality risk in the middle of the nineteenth century as well.

[16]The results are consistent with those of Goldin and Margo (1989).

[17]Rates of birth injuries are probably underestimated because they do not include clearly classifiable categories such as "edema of the brain" or "compression of the brain."

Figure 2: Percentage of Children (All Gestations) Dying Within Ten Days of Birth by Birth Weight, New York Lying-In (1910-1931), 1950 National Sample, and 1988 National Maternal and Infant Health Survey



Note. Estimates from both the New York Lying-In sample and the 1988 National Maternal and Infant Health Survey are weighted. Estimates for 1950 are from Tables 1 and 2 in U.S. Department of Health, Education and Welfare (1965: 249-250). The weight intervals are centered at the marks and are 1500 grams or less, 2000 to 2500 grams, 2501 to 3000 grams, 3001 to 3500 grams, 3501 to 4000 grams, 4001 to 4500 grams, and 4501 grams and over.

Table 7: Causes of Death (Percent of All Deaths) in First Days of Life in New York Lying-In sample (1910-1931), 1950 National Sample, and 1988 National Maternal and Infant Health Survey

	1910-1931 New York Lying-In Gestational Age (Weeks)		1950 (U.S.) All Gestational Ages	1988 (U.S.) Gestational Age (Weeks)	
	All	37+		All	37+
Postnatal Asphyxia or Atelectasis or Respiratory Distress Syndrome (RDS)	27.8	29.0	21.4	22.9	13.7
With hemorrhage	11.8	9.7			
Without hemorrhage	16.0	19.4			
Pneumonia	8.3	9.7	2.3	0.7	1.0
Congenital Disorders	6.9	8.1	11.7	33.2	57.8
Immaturity	22.2	6.5	30.2	12.0	3.2
Birth injury	20.1	32.3	18.5	0.7	0.8
Cerebral hemorrhage	9.0	16.1			
Other hemorrhage (not disease)	6.9	9.7			
Other causes	14.6	17.7	15.9	28.5	23.5

Note. All babies were white. All deaths in the New York Lying-In sample and in the 1988 sample are those within the first ten days of life and are for married mothers. All deaths in 1950 are within the first six days of life and are for all women. The numbers for pneumonia do not change if all children born in the year of the influenza epidemic are excluded. The 1988 estimates are weighted.

Table 8: Deaths Per 1000 Live Births by Cause in First Days of Life in New York Lying-In sample (1910-1931), 1950 National Sample, and 1988 National Maternal and Infant Health Survey

	1910-1931 New York Lying-In Gestational Age (Weeks)		1950 (U.S.) All Gestational Ages	1988 (U.S.) Gestational Age (Weeks)	
	All	37+		All	37+
Postnatal Asphyxia or Atelectasis or Respiratory Distress Syndrome (RDS)	9.73	1.96	4.07	0.82	0.16
With hemorrhage	4.13	0.66			
Without hemorrhage	5.60	1.31			
Pneumonia	2.91	0.66	0.44	0.03	0.01
Congenital Disorders	2.42	0.55	2.22	1.19	0.69
Immaturity	7.77	0.44	5.74	0.43	0.04
Birth injury	7.04	2.19	3.52	0.03	0.01
Cerebral hemorrhage	3.15	1.09			
Other hemorrhage (not disease)	2.42	0.66			
Other causes	5.11	1.20	3.02	1.02	0.28

Note. All babies were white. All deaths in the New York Lying-In sample and in the 1988 sample are those within the first ten days of life and are for married mothers. All deaths in 1950 are within the first six days of life and are for all women. The numbers for pneumonia do not change if all children born in the year of the influenza epidemic are excluded. The 1988 estimates are weighted.

was negligible. At New York Lying-In deaths from immaturity and atelectasis without mention of hemorrhage were disproportionately concentrated among low birth weight babies. Among babies of all gestational ages, postnatal asphyxia, atelectasis, and respiratory distress syndrome have remained major causes of death (though their incidence has fallen), perhaps because more low birth weight babies are now delivered alive. In fact, among babies of 37 weeks or more gestational age, the fraction dying from postnatal asphyxia, atelectasis, or respiratory distress syndrome is now half of what it used to be. Today, the bulk of deaths are due to congenital causes because the chance of dying from another cause is relatively low. Findings implying that willingness to perform caesarean delivery in the modern hospital after 26 weeks of gestation significantly reduced neonatal mortality (Bottoms *et al.* 1997) provide further evidence of the importance of improving obstetrical practice.

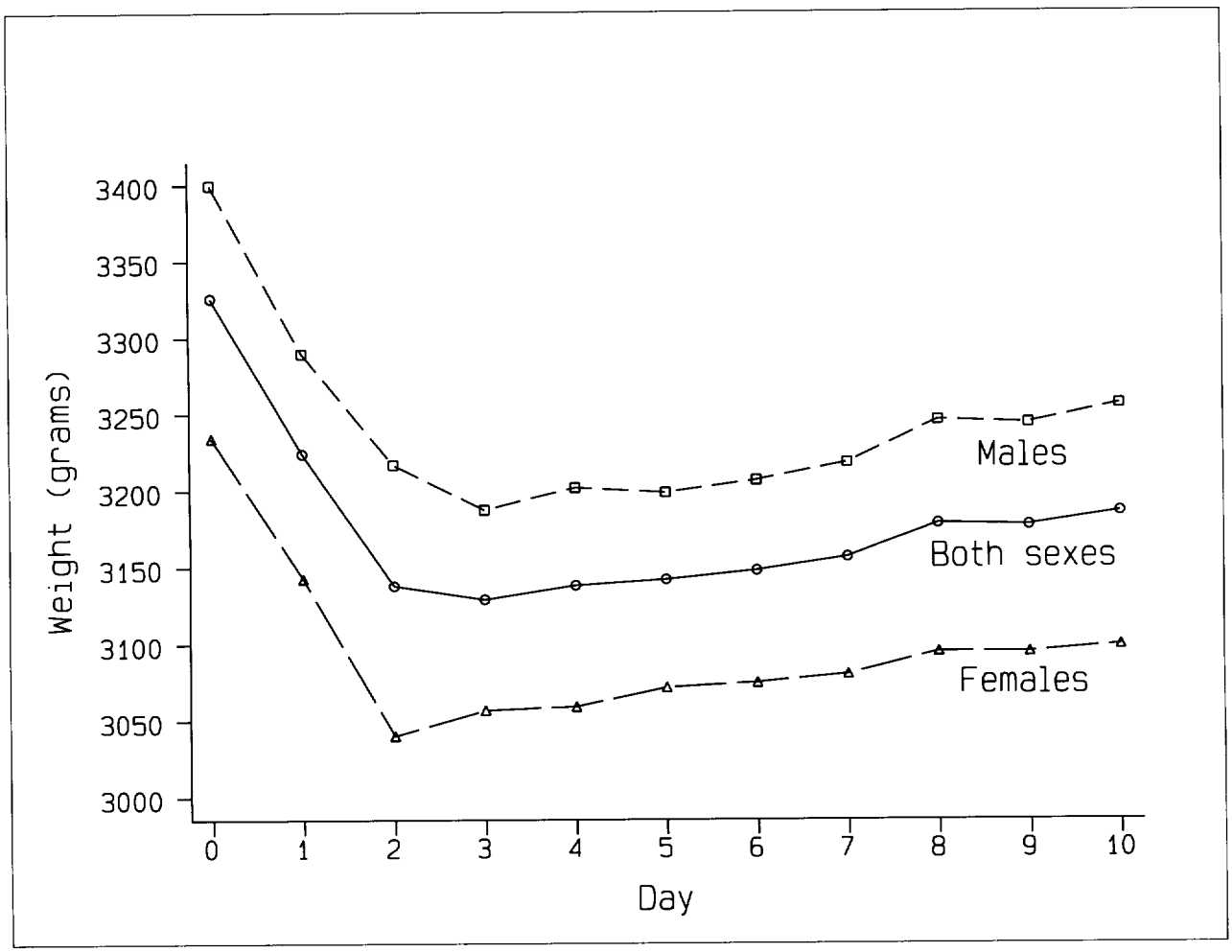
A worsened neonatal mortality experience was not the only functional implication of low birth weight. Low birth weight babies were also lighter at ten days of age than high birth weight babies, both because of their initially lower birth weight and because they experienced slighter lower weight gains.

All of the children at New York Lying-In, regardless of birth weight or paternal income, were much lighter at day ten than modern babies.[18] Three-quarters of them had not regained their birth weight by the tenth day. Males weighed 144 grams less on average on the tenth day than at birth and females 135 grams (see Figure 3). Given that the weights, lengths, and head circumferences of the children born at New York Lying-In compared favorably with modern standards, this failure to thrive is striking.

The most likely cause of failure to thrive was insufficient feeding. It was the common practice in hospitals to feed infants every four hours, sometimes even every eight (Apple 1987:

[18]Only children in the indoors department were weighed after birth, but given that weight at day ten depended heavily upon birth weight, this statement applies to the sample as a whole as well.

Figure 3: Weight from Birth to Day Ten, New York Lying-In (1910-1931)



Note. Weights are for children born in the indoor department and include only children for whom weights for all days were given.

127), rather than every two as recommended today. Some of the records of New York Lying-In contain instructions as to how often the infant should be fed. The most common instruction was every four hours. When infants are divided into those who were fed every three or more hours and into those who were fed every four or fewer hours, those who were fed every three or more hours were 127 grams heavier on the tenth day than at birth and those who were fed every four hours or fewer hours were 98 grams lighter than at birth. Neither the characteristics of the mother nor of the child predicted the frequency of feeding. The frequency may have depended upon the convenience of the hospital staff, the doctors' determination of how exhausted the mother was, or the pediatrics textbook that the doctor was familiar with. Tuley (1904: 29) wrote that "Feeding should be regular, every two hours during the day until three months of age, and every three hours at night." Twenty years later, Kerley and Graves (1924: 47) wrote, "From birth until the third month seven feedings in twenty-four hours are allowed as follows: 6 and 9 A.M., 12 M., 3 and 6 P.M., and 2 A.M." It did not matter if an infant woke earlier crying with hunger or if the infant was sleepy at the prescribed nursing time. Most likely, infants born at home were not fed often enough either. A booklet of "practical advice for mothers and nurses" stated that "Feeding a baby whenever it cries results disastrously" and recommended seven feedings, but then stated that "Often the infant is able to get along with four-hour periods [of feeding]. This is better still, and should be encouraged" (Lyman 1922: 61-62). The same booklet stated that the baby did not regain its birth weight before the tenth to the twentieth day (Lyman 1922: 15).

It was not just children born in the first third of the century who were not fed often enough. Even mid-nineteenth century manuals emphasized that after a week of demand feeding it was necessary to nurse the infant at regular intervals of three or four hours, day and night. By the twentieth century, manuals recommended that regular feeds begin the first day of life. Some authorities believed that anything less than a three-hour feed did not give the stomach enough rest. Others worried that babies were being overfed. The recommended number of feeds was

gradually reduced to every four hours. Only after World II did the trend towards reduced feedings reverse and demand feeding become the norm, popularized by Dr. Benjamin Spock in 1946 and advocated in official US Bulletins on baby-care in the 1950s (Hardyment 1983: 48, 125, 225).

Babies born at New York Lying-In, beginning life with birth weight, length, and head circumference above the 1976 50th percentile and experiencing a reversal of fortune by day ten, may never again have achieved the 1976 median. *Holt's Diseases of Infancy and Childhood* shows that although the median birth weight of boys was higher than the 1976 median, by one month of age, the median weight was below the 1976 median and did not return to the 1976 median until 12 months of age (p. 14). Baldwin (1921: 37,39, 60-63) reported weights of babies weighed by the Baby Milk Fund Association of Baltimore and weights and lengths of babies in good health weighed in Iowa circa 1918. The mean weight and length of all babies at birth were greater than the 1976 medians, but their mean weight and lengths at 12 months were below the 1976 median and were still below the 1976 median at 36 months.[19] These children may never have been fed enough to catch up in terms of weight to children today, particularly given prevalence rates for infectious disease. Kerley and Graves (1924: 18) reported that, "Left to the family, the diet during the second year too frequently consists of milk, which in large cities is often of uncertain nutritive value, together with insufficiently cooked cereals, boxed breakfast foods, bread-stuffs, crackers, and cake." Trends in adult heights are suggestive. Adults born in the first half of the century were shorter than those born in the 1950s when demand feeding was all the rage and when the prevalence of childhood infections had fallen (Costa and Steckel 1997).

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[19]The 1976 medians are from (Behrman and Vaughan 1983: 27).

6 Implications

This paper has shown that differences in birth weight by income class were larger in the past than they are today. In the New York Lying-In data, a sample of working class households in 1910-1931, the difference in birth weight between the 90th and 10th percentiles of the wage distribution was 118 grams. In contrast, among all white, married women in 1988, the difference in birth weights was 52 grams in a national sample and 11 grams in a socioeconomically comparable sample. Differences in maternal height and therefore in the mother's net nutritional status during her growing years accounted for most of the difference in birth weight by income class in the New York Lying-In sample, but not in recent data, implying that in the past health inequality was transmitted across generations. The intergenerational transmission of health inequality in turn implies that health inequality may narrow only after a long period of time.

Although socioeconomic differences in birth weights were not large in 1910-1931 and although this paper has shown that babies born at New York Lying-In compared very favorably in terms of birth weight, length, and head circumference to babies born today, the consequences of low birth weight and therefore of poverty were much more severe at the beginning of this century than they are today. All babies born at New York Lying-In faced higher death rates in the first days of life than babies born today, but the difference was particularly pronounced at high and low birth weights, suggesting that poor obstetrical and medical knowledge may have led to more deaths. Babies with low birth weights also weighed less on the tenth day of life, implying that the impact of low birth weight lasted through day ten and probably beyond. The reduction of health inequality at later ages may therefore necessitate lowering health inequality at very early ages.

Birth weights at New York Lying-In may have compared favorably to those of modern populations because many low birth weight babies never survived childbirth. Fetal death rates were three times as high in the first half century as they are today. But, although babies born at

New York Lying-In began life with anthropometric measurements above the 1976 50th percentile, by day ten these children were below the 50th percentile, largely because the best medical advice of the period produced insufficient feeding.

The findings reported in this paper imply that technological change has played an important role in well-being. Improved obstetrical and medical knowledge has lowered the fetal and neonatal death rate, particularly at lower birth weights. Improved nutritional knowledge has permitted all babies to thrive in their first days of life and may in part account for improvements in average health from the first to the second half of the century. These advances in obstetrical, medical, and nutritional knowledge have come slowly and progress has not always been linear. In the New York Lying-In data, the prevalence of breast feeding falls sharply from 1910 to 1931, a trend that was true of the United States as a whole (Apple 1987: 154). In the 1950s and 1960s, birth weights of children fell because obstetricians tried to eliminate certain ailments commonly associated with pregnancy by restricting the weight gain of pregnant women (Beal 1980: 137-138). Nonetheless, the data suggest that technological advances improved birth outcomes dramatically in the latter half of the twentieth century and therefore may have improved health outcomes at adult ages as well.

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