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THE URBAN MORTALITY TRANSITION IN THE UNITED STATES, 1800-1940

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ABSTRACT

In the United States in the 19th and early 20th centuries, there was a substantial mortality "penalty" to living in urban places. This circumstance was shared with other nations. By around 1940, this penalty had been largely eliminated, and it was healthier, in many cases, to reside in the city than in the countryside. Despite the lack of systematic national data before 1933, it is possible to describe the phenomenon of the urban mortality transition. Early in the 19th century, the United States was not particularly urban (only 6.1% in 1800), a circumstance which led to a relatively favorable mortality situation. A national crude death rate of 20-25 per thousand per year would have been likely. Some early data indicate that mortality was substantially higher in cities, was higher in larger relative to smaller cities, and was higher in the South relative to the North. By 1900, the nation had become about 40% urban (and 56% by 1940). It appears that death rates, especially in urban areas, actually rose (or at least did not decline) over the middle of the 19th century. Increased urbanization, as well as developments in transport and commercialization and increased movements of people into and throughout the nation, contributed to this. Rapid urban growth and an inadequate scientific understanding of disease processes contributed to the mortality crisis of the early and middle nineteenth century in American cities. The sustained mortality transition only began about the 1870s. Thereafter the decline of urban mortality proceeded faster than in rural places, assisted by significant public works improvements and advances in public health and eventually medical science. Much of the process had been completed by the 1940s. The urban penalty had been largely eliminated and mortality continued to decline despite the continued growth in the urban share of the population.

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INTRODUCTION

In the United states in the 19th century, as in Europe in that era, there was a substantial mortality "penalty" to living in urban places [e.g., Williamson, 1982, 1990, ch. 9; Davis, 1973; Weber, 1899, ch VI; Brown, 1991; Voegele, 1994]. By 1940, that urban penalty had been largely eliminated; and it was healthier, in many cases, to reside in a city than in the countryside. Part of the study of the great mortality transition in the United States is related to this phenomenon.

A significant problem with the history of mortality in the United States stems from the paucity of good statistical information – on levels, trends, and differentials. It is possible, however, using a variety of sources and demographic estimation methods, partially to reconstruct the course of mortality in the United States from 1800 onwards and, more particularly, to provide some insight into differentials. When census data, vital statistics, local records, and genealogical data are culled for what they can reveal, the outlines appear.

Although the United States was the first nation to introduce a regular census (taken decennially from 1790 onwards), vital registration was left to state and local governments. Consequently, it was instituted unevenly. A variety of churches kept parish records of baptisms, burials, and marriages, and these have been used to construct demographic estimates for the colonial period, especially for New England and the Middle Atlantic regions. Although some cities (e.g., New York, Boston, New Orleans, Baltimore, Philadelphia) began vital registration earlier in the 19th century, the first state to do so was Massachusetts in 1842. An official Death Registration Area (DRA) consisting of ten states and the District of Columbia was only successfully established in 1900, and data collection from all states was not completed until 1933. A parallel Birth Registration Area (BRA) was only instituted in 1915, and collection for all states was also achieved in 1933. There were also a significant number of "Registration Cities" outside the DRA and BRA were also included in the data reporting until 1933.[1] The federal census did collect mortality information with the censuses of 1850 to 1900, but there were significant problems with completeness. The data do improve over time, and, after 1880, census information was merged with state registration data [Condran and Crimmins, 1979]. Nothing similar, however, was undertaken for birth data.

In the early 19th century, the United States was a relatively low mortality regions

[1] Appendix Tables A-1 and A-2 provide some characteristics of the Death and Birth Registration Areas and the dates at which various states entered.

by the standards of Western Europe. Since it was not particularly urban (only 6.1% in 1800), a crude death rate in the range of 20-25 per 1,000 population would not have been unusual. The low mortality was remarked upon by none other than Thomas Robert Malthus [1798, pp. 104-106]. Mortality was likely lowest in New England and rose as the latitude moved further south. Such evidence as we have (mostly for New England the Middle Atlantic states) does indicate a substantial urban penalty. By 1900 within the Death Registration Area (the six New England states, New York State, Pennsylvania, Michigan, Indiana, and the District of Columbia), the expectation of life at birth (e(0)) for the urban white population was 46 years, while it was 54.7 years for the rural white population [Glover, 1921]. Estimates of child mortality for the whole United States based on indirect estimates using the 1900 Public Use Micro Sample of the census find that mortality in urban areas was 13% above the national average, and 22% above the average for rural places [Preston and Haines, 1991, Table 3.1]. These estimates apply to about 1894. The urban penalty had declined to approximately 6% above the national average and 13% above the rural rate using indirect estimation with the national sample of the 1910 census [Preston, Ewbank, and Hereward, 1994, Table 3.2]. (See Table 2.) For the Death Registration Area of 1900, urban-rural differentials in e(0) for white males decreased from 10.0 years in 1900/02 to 7.8 years in 1909/11 and to 2.6 years in 1939 for the whole United States [United Nations, 1953, p. 62 and Table 1]. Higgs [1973] estimated that urban mortality was 50% higher than rural mortality in the 1880s, and that the urban penalty had dropped to 21% by the period 1910/20. Condran and Crimmins [1978, 1980] and Crimmins and Condran [1983] found that the rural-urban mortality difference was already diminishing in the 1890s, and that the urban penalty was largely due to tuberculosis, diarrheal diseases, and several other infectious, communicable diseases.

This paper will look at the phenomenon of the urban mortality transition over the period 1800 to 1940 using a variety of sources. Particular attention will be paid to the 19^{th} and early 20^{th} centuries, when we know considerably less and before many of the most heralded public health innovations had come into play. Using some new data, re-analyzing old data, and looking at the history of public health will provide clues as to the relationship of public health (broadly defined) to the urban mortality transition.

THE URBAN MORTALITY TRANSITION IN THE UNITED STATES

It is clear that, before about 1920, urban mortality was much in excess of rural mortality. In general, the larger the city, the higher the death rate. A variety of circumstances contributed to the excess mortality of cities: greater density and crowding, leading to the more rapid spread of infection; lack of adequate clean fresh water and sewerage disposal; a consequently higher degree of contaminated water and food; garbage and carrion in streets and elsewhere not properly disposed of; larger inflows of foreign migrants, both new foci of infection and new victims; rapid turnover of both goods and people; and also migrants from the countryside who had not been exposed to the harsher urban disease environment [Haines, Weiss, and Craig, 2000; Melosi, 2000; Duffy, 1990]. Writing in 1899, Adna Weber commented on the positive relationship between city size and mortality levels for the United States and Europe:

> "It is almost everywhere true that people die more rapidly in cities than in rural districts....There is no inherent or eternal reason why men should die faster in large communities than in small hamlets....Leaving aside accidental causes, it may be affirmed that the excessive urban mortality is due to lack of pure air, water and sunlight, together with uncleanly habits of life induced thereby. Part cause, part effect, poverty, overcrowding, high rates of mortality, are found together in city tenements" [Weber, 1899, pp. 343-348].

According to the Death Registration Area life tables for 1900/02, the expectation of life at birth was 48.2 years for white males overall -- 44 years in urban areas and 54 years in rural places. The comparable results for females were similar (51.1 years overall, 48 years urban, 55 years rural) [Glover, 1921]. (See Table 1.) For the seven states with reasonable registration data in both 1890 and 1900, the ratio of urban to rural overall crude death rates reported in the 1890 census was 1.32, and 1.17 in 1900. (See Table 2.) The death rates for young children (aged 1-4) the ratios were much higher, with urban mortality being 94% higher in 1890 and 100% higher in 1900. For infants the excess urban mortality was 88% in 1890 and 48% in 1900. Residence in cities, with poorer water quality, lack of refrigeration to keep food and milk fresh, and close proximity to a variety of pathogens was very hazardous to the youngest inhabitants. The rural-urban differential seems to have been true earlier as well. For seven New York counties in 1865, the probability of dying before reaching age five was .229 in urban areas but .192 in rural locations [Haines, 1977]. A study of Massachusetts by Vinovskis found that the largest cities and towns had a lower e(0) in 1859-61, but differentials below that size were less clear. He believed that the differences had been larger in the 17th and 18th centuries [Preston and Haines, 1991, pp. 36-39; Vinovskis, 1981, ch. 2; Condran and Crimmins, 1980].

In the early 19th century, the United States was an area of relatively low mortality by the standards of Western Europe. It was quite rural (only 6.1% urban in 1800); and a crude death rate in the range of 20-25 per 1,000 population would not have been unusual. The low mortality was noted by contemporary observer Samuel

Blodget [1806, p. 76] who suggested crude death rates in the low 20s for rural areas and about 24-26 for the entire nation, but considerably higher in larger cities (in the range 27-30). The Jaffe and Lourie [1942] life tables for 1826/35 (based on local registration materials and census populations for 1830) show that the expectation of life at age 10 (e(10)) was 51.0 years for 44 smaller New England towns, whereas it was 46.0 for Salem, MA and New Haven, CT (medium-sized cities) and 35.9 years for Boston, New York City, and Philadelphia. (See Table 2.)

Given the paucity of vital statistics data in the 19th century, it is difficult to describe the process of the mortality transition. One place to start is with city vital registration. Figures 1 to 5 trace the simple crude death rate for five large cities from the early 19th century: New York City (1804-1920), Boston (1811-1920), Philadelphia ((1802-1920), Baltimore (1811-1920), and New Orleans (1810-1920). The data come from a variety of sources, but seem to be of reasonable quality.

New York City (Figure 1) is quite a good case.[2] Prior to about 1870, the approximate point of the onset of the overall mortality transition in the United States, New York City experienced serious mortality peaks, notably from the cholera epidemics of 1832, 1849, 1854, and 1866 [Rosenberg, 1962]. Further, baseline mortality appeared to be increasing before the American Civil War (1861-65). This was probably not because of the improving quality of death registration. The mortality statistics seemed to be quite reasonable from early on [Duffy, 1968, pp. 532-534]. This is also consistent with the "Antebellum Puzzle": the finding that heights were declining among adult males born between about 1830 and 1870 at the same time that mortality was rising throughout the United States [Fogel, 1986; Haines, 1998b; Haines, Craig, and Weiss, 2000; Steckel, 1992, 1995; Komlos, 1987, 1994, 1996]. This was in the face of quite robust economic growth. One conclusion is that the mortality and disease environments were being made national and international in scope during the 19th century. The more rapid and extensive movement of people and goods due to the "Transportation Revolution" [Taylor, 1951] also brought a negative side [Haines, Craig, and Weiss, 2000]. The rapid spread of the Asiatic cholera from 1829 in Russia to 1832 in most of the rest of the world is ample testimony to the new international disease environment [Rosenberg, 1962, ch. 1]. This recurred in 1849, 1866, and 1893. The New York City data also indicate a damping of fluctuations after mid-century, as well as finally a sustained decline from about 1890.

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[2] The mortality data come from [Rosenwaike, 1972]. The population data come from the federal and state censuses for New York.

A somewhat similar picture emerges in Figure 2 for Boston (1811-1920).[3] Boston experienced, if not an increase in mortality over the first half of the century, at least no decline. Also, mortality was quite variable, notably around the great cholera epidemic of 1849. A sustained diminution in death rates did not begin until the 1880s. Philadelphia's crude death rate is depicted in Figure 3.[4] The experience was similar to New York City and Boston in that the first half of the century was characterized by high mortality levels and considerable variability. Philadelphia was hard hit by outbreaks of yellow fever early in the century and then by the Asiatic cholera in 1832, 1849, 1854, and 1866. The sustained mortality decline commenced in the early 1870s, greatly furthered by construction of waterworks and sewers and other public health measures [Condran and Cheney, 1982; Melosi, 2000, passim].

The crude death rate for the city of Baltimore is presented in Figure 4.[5] Baltimore had a very difficult sanitation situation based on its topography [Cain, 1977]. It had a low-lying location on the Patapsco River estuary of Chesapeake Bay. Construction of gravity flow sanitary sewers was problematic. Further, the Chesapeake region had been a place with significantly elevated mortality since colonial times [Carr, 1992; Wells, 1985, pp. 65-71.]. Nonetheless, mortality peaks did dampen after about 1870 and a sustained transition set in.

The final Figure 5 is for the remarkable case of New Orleans, Louisiana. The death rates there were so high in the 19th century that the scale of the figure had to be compressed by a factor of three to fit it on the page.[6] Mortality was truly virulent and peaks astonishing before the late 19th century. Yellow fever was especially severe in the marshy, swampy flat area near the delta of the Mississippi River, but cholera, typhoid fever, malaria, dysentery, and other water- and insect-borne diseases were both endemic and epidemic [Pritchett and Tunali, 1995; Bloom, 1993, ch. 3]. Despite the possibility of defective death registration, mortality in

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[3] The data are from Shattuck [1846] and from various reports of the vital statistics of Massachusetts. Federal and state censuses were used to make the annual population estimates.

[4] The vital data originated in the compilation of vital data in Klepp [1991] and in various volumes of the Mayor's Reports. Annual population estimates are based on federal census returns. Adjustments were made for the changing boundaries of the city.

[5] These data come from Howard [1924].

[6] The mortality statistics were furnished by Jonathan Pritchett and come from various city reports [Pritchett and Tunali, 1995]. The population estimates were based on federal census results.

the city appears to have been astounding. Indeed, it has been characterized as the nation's "death capital" [Pritchett and Tunali, 1995, p. 518]. It is curious that the city actually would publish these statistics, since they only illustrated the danger of settling in this bustling commercial city. But the city managed to grow robustly over the 19th century at a rate of about 3% per year for the period 1810 to 1910 (and 4.6% per annum for the antebellum decades 1810 to 1860). The baseline mortality was very high, averaging around 50 deaths per 1,000 population in the pre-1860 era. In no year did the crude death rate fall below 25 and only four times went below 30 in the 50 year span. In 12 of the 35 years between 1825 and 1860, more than 1,000 persons died of yellow fever alone, not to mention other infectious and parasitic diseases. In the great epidemic of 1853, more than 8,000 persons perished from this insect-borne disease (out of a total population of about 125,000 at the onset of the epidemic) [Pritchett and Tunali, 1995, pp. 518-519].

One must conclude that large American cities had become virtual charnel houses by the middle of the 19th century and that this contributed notably to the rising mortality in the United States before the American Civil War. Some of this may be seen in the estimates of Pope [1992] and Fogel [1986]. Some additional evidence on the effect of urbanization and transport on mortality can be found with the county level census death data from the U.S. Census of 1850 [Haines, Craig, and Weiss, 2000].[7] Counties in 1850 with access to water and/or railroad transportation had crude death rates (adjusted for undercount) of 20.5 deaths per 1,000 population, in contrast to those without such access (at 15.6). Counties with less than 1% of the population living in urban areas had crude death rates of 17.7 per 1,000 population, while those with 1%-25% urban had average death rates of 19.2 and those with more than 25% of the population urban had death rates of 25.4. The zero-order correlation between the estimated county crude death rate was .28 with the variable for transport access and .20 with the percent urban.

As Figures 1-5 demonstrate, large cities did not gain significant control over their mortality environments until the latter part of the 19th century. Even then, some smaller New England cities were especially resistant to change, e.g. Holyoke and Northampton in Massachusetts. The situation in New England at this time has been called the "nineteenth-century mortality plateau" [Hautaniemi, Swedlund, and Anderton,

[7] Despite the fact that these data undercount actual deaths by about 40%, they are usable [Haines, 1979]. It is likely that differences in reporting were consistent across space.

1999, esp. p. 34]. Among recent works, there has been strong support for water and sewerage projects as effective in reducing urban mortality from the later 19th century. (See, for example, Condran and Cheney [1982]; Hautaniemi, Swedlund, and Anderton, [1999]; Cain and Rotella [1998]; Troesken [1999a, 1999b]; Melosi, [2000].)

So the excess urban mortality was diminishing from the late 19th century onwards, especially as public health measures and improved diet, shelter, and general living standards took effect. The excess in e(0) for rural white males over those in urban areas was 10 years in 1900. This fell to 7.7 years in 1910, 5.4 years in 1930, and 2.6 years by 1940. In addition, by 1940 the difference between the largest cities (100,000 and over) was very small (an e(0) for white males of 61.6 in the largest cities in contrast to 61.4 in other urban places). This was certainly not true in 1900, when the ten largest cities had mortality 22% above that of the smallest urban places and that of other cities of 25,000 and over was 39% higher. [See Table 1; Dublin, Lotka, and Spiegelman, 1949, p.324; Preston and Haines, 1991, Table 3.1.]

The original cause of the rural advantage was unlikely superior knowledge of disease, hygiene, and prevention in rural areas, since farmers were not known to be particularly careful about disease and cleanliness: "There are few occupations [other than farming] in which hygiene is more neglected" [Abbott, 1900, p. 71]. The rural advantage seems simply to have been that rural residents were farther from each other, reducing chances of contagion and contamination of water supplies. Rural-urban mortality differentials likely played a role in the deterioration of mortality in the middle of the 19th century, as the population shifted to cities and towns. Also, the 20th century mortality decline was significantly propelled by the elimination of excess urban deaths [Preston and Haines, 1991, pp. 36-39; Taeuber and Taeuber, 1958, pp. 274-275].

The black population of the United States certainly experienced higher death rates, both as slaves and then as a free population in the postbellum period than did whites. Tables 1 and 2 provides some information on the expectation of life at birth and the infant mortality rate by race. As of 1920, when reasonably representative data are available for the black population in the official registration states, it is apparent that the mortality of blacks was substantially higher. Ironically, they were protected to some extent by their more rural residence. In 1900, about 80% of the black population was rural, in contrast to about 60% for whites [U.S. Bureau of the Census, 1975, Series A 73-81]. Using the 1900/02 DRA life tables alone, the black population could be seen to have had an e(0) of about 33.5 years and an infant mortality rate of about 233 infant deaths per 1,000 live births. But using indirect estimation techniques for the public use sample of the national black population in 1900 revealed considerably more favorable results: an e(0) of 41.8 years and an infant mortality rate (IMR) of 170. This indicated that a great disadvantage was still there but that rural residence had its advantages, even for the poor [Preston and Haines, 1991, ch. 2].

Higgs [1973] estimated that urban mortality was 50% higher than rural mortality in the 1880s, and that the urban penalty had dropped to 21% by the period 1910/20. He found the following upper bounds for the ratios of urban to rural mortality by decade from 1870 to 1920:

Decade	Ratio
1870-1880	1.38
1880-1890	1.50
1890-1900	1.35
1900-1910	1.33
1910-1920	1.21

Condran and Crimmins [1978, 1980] and Crimmins and Condran [1983] found that the rural-urban mortality difference was already diminishing in the 1890s, and that the urban penalty was largely due to tuberculosis, diarrheal diseases, and several other infectious, communicable diseases. Their analysis is augmented and brought forward in time to 1940 in Table 3. For the seven states for which we have consistent information from 1890 onwards, mortality declined over the whole period 1890 to 1940; and rural-urban convergence was complete by 1920 for the overall death rate and by 1930 for the infant mortality rate. Convergence was taking place for the death rates for ages above one, but it was less pronounced. This is consistent with a cohort view of the process. The improvements in mortality were concentrated among the younger cohorts and so convergence was more rapid. Older persons, who had been subjected to the biological insults of earlier, higher mortality regimes, did experience mortality declines, but less dramatically and with less rural-urban convergence. This may also be seen in Table 1, where the relative differences were reduced more for the infant mortality rate and e(0) (which is heavily influenced by infant mortality) than expectation of life at age 10 (e(10)). The results for all states in Table 3 is a bit misleading because there were compositional changes over time as the Death Registration Area was augmented. Nonetheless, the infant mortality rate achieved full convergence in the 1920s; and, by the 1930s, cities were actually better places for infants to survive the first year of life.

The results before 1930 based on national vital statistics apply to the Death Registration Area, which did not completely cover the United States until 1933 with the admission of Texas to the system.[8] It is possible, however, to make estimates of childhood mortality for the entire nation from the censuses of 1900 and 1910, using the microdata samples and the questions on children ever born, children surviving, and duration of marriage [Preston and Haines, 1991; Preston, Ewbank, and Hereward, 1994; Haines and Preston, 1997].[9] The method makes use of an index of child mortality based on the data recorded in the census. The index is the ratio of cumulative child deaths that a woman has experienced (i.e., the difference between her numbers of children born and surviving) to her expected number of child deaths. The expected number of deaths is calculated by multiplying her number of children-ever-born by an expected proportion dead. The expected proportion dead is based in turn on an estimate of the length of her children's exposure to the risk of mortality, combined with a West model life table. For 1900 the standard used to calculate the expected proportion of children dying is a West Model life table with both sexes combined, level 13.0 (implying an e(0) of 48.5 years). For 1910, it is the same but with the level set at 13.5 (with an implied e(0) of 49.7 years).[10]

Table 4 presents estimates of rural and urban childhood mortality, using these indirect techniques with the censes data from 1900 and 1910. Between about 1894 and about 1904, then, convergence between rural and urban mortality was taking place. As with the more limited data from the Death Registration Area, urban mortality exceed rural, by 22% in 1900 and 13% in 1910. Thus convergence was indeed taking place; or, to state it differently, urban mortality was declining more rapidly than rural mortality (12.1% for urban mortality versus 5% for rural mortality). Interestingly, in 1900 the largest cities ("Top 10 Cities") had an advantage over the next tier of large cities ("Other Cities 25,000+"). This was most likely because of the greater resources available to those largest cities to undertake the significant infrastructure investments in public health, particularly sanitary water and sewerage systems. But by 1910, this advantage has dissipated. The childhood mortality index

[8] See Appendix Tables A-1 and A-2.

[9] The estimates actually apply to a period about five to six years before each census, i.e., 1894 and 1904 respectively.

[10] For more precise details on the calculation of the index, see Haines and Preston [1997], Appendix.

had fallen by only 5% in the top ten cities but by over 22% in the other cities of 25,000 and over (and by 12.6% in cities of 5,000 to 25,000 in population).[11] The top ten cities of 1900 showed rather uneven patterns of change over the decade. Overall, however, these national estimates do show that rural and urban mortality were moving closer together as they both declined around the turn of the century. This confirms the results for the Death Registration Area and specific state data from Table 3.

A longer term perspective is presented in Table 5, which has the infant mortality rate, e(0), and e(10) for the state of Massachusetts and for Boston (Suffolk County at most dates).[12] Although this is not an ideal comparison, since Boston also appears in the state totals, it is useful.[13] Nonetheless, there also appears to be a staged convergence of the largest city with the rest of the state. By the 1870s there is some movement towards a ratio of 1.0 (equality), then a plateau, and finally a roughly complete convergence for the infant mortality rate by the 1890s and a bit later for e(10) and e(0). Also notable is the delayed transition in the infant mortality rate relative to mortality at older ages (e(10)).

Finally, Table 6 gives the infant mortality rate for the Birth Registration Area for the period 1915 (when it was created) to 1932 and for 1933 to 1940 for the entire United States. The last three columns provide the ratio of rural to urban infant mortality, using cities of 10,000 and over in population as the urban category.[14] Again bearing in mind that the Birth Registration Area is growing up to 1932 (and hence compositional issues are created),[15] these results also point to convergence by the 1920s for the white population, but later for the nonwhite population (mostly African Americans). Uniformly the nonwhite population had higher infant mortality, in both rural and urban areas, although (except for the first two years) urban mortality exceeded rural. The rural-urban gap was closing, but it had not been eradicated by 1940 as it had been for the white population. And nonwhite infant mortality rates

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[11] It should be noted that there are compositional effects here, since the set of cities differs between 1900 and 1910 because of population growth.

[12] Boston made up about 90% or more of the population of Suffolk County throughout.

[13] Boston was 95% of the population of Suffolk County in 1850, and Suffolk County was 14.5% of the population of Massachusetts at the same date. The same percentages were 89% and 21% for 1930.

[14] One is constrained to use the categories in which the data are presented. Clearly 10,000 and over is a rather high urban threshold.

[15] See Appendix Table A-1.

were still higher than those for whites at the end of the 1930s – 70% higher overall, 85% higher in urban places, and 53% higher in rural areas. These same results can also been seen in Table 1 for e(0) and e(10) for 1930 and 1939.

Some confirmation of this may be obtained from an analysis of county level data from period 1930 to 1940 [Fishback, Haines, and Kantor, 2000]. For all the counties of the United States for which we have data, the infant mortality rate for 1930/32 was correlated only .046 with the percent urban in 1930. The same result correlating the infant mortality rate for 1933/39 with the percent urban for 1940 was merely .013. Neither correlation was statistically significantly different from zero. Clearly urbanization did not have an effect by 1930 as it did in 1850. The results were different for the South. There the correlations in 1930 were .117 overall, .156 for whites and .201 for blacks. The results for 1940 were .112 overall, .177 for whites, and .200 for blacks.[16] Thus nationally convergence was evident, but this was not the case in the South, especially for the African-American population.

URBAN PUBLIC HEALTH AND THE EPIDEMIOLGICAL TRANSITION

What were the origins of the "epidemiologic transition" in the United States? A variety of factors affect mortality. They may conveniently be grouped into ecobiological (i.e., changes is disease vectors and processes), public health, medical, and socioeconomic. These categories are not mutually exclusive, since, for example, economic growth can make resources available for public health projects and advances in medical science can inform the effectiveness of public health. Ecobiological factors were not likely significant. While there may have been favorable changes in the etiology of a few specific diseases or conditions in the 19th century (notably scarlet fever and possibly diphtheria), reduced disease virulence or changes in transmission mechanisms were not apparent [Omran, 1973].

The remaining factors, socioeconomic, medical, and public health, are often difficult to disentangle. For example, if the germ theory of disease (a medical/scientific advance of the later 19th century) contributed to better techniques of water filtration and purification in public health projects, then how should the roles of medicine versus public health be apportioned? Medical science did have a rather limited direct role before the 20th century. Public health did, however, play a much more important role and thereby indirectly allowed medicine a part.

It is not the case that public authorities in large American cities were unaware

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[16] The data reported in the vital statistics did not report race separately outside the South.

of the health issues or unwilling to deal with them. In New York City, for example, a Health Office was established in 1796, although the truly effective Metropolitan Board of Health was not created until 1866. Most other large cities had health office or boards by the early 19th century. In 1844 New York City brought the vital Croton Reservoir and 40 mile Croton Aqueduct into service, bringing large quantities of clean water into the burgeoning metropolis. Boston secured an abundant municipally controlled external fresh water supply with the opening of the Cochituate Aqueduct in 1846. Chicago, which drew on Lake Michigan for its water, also had to cope with sewage disposal directly into its water supply from the Chicago River. Water intakes were moved further offshore in the 1860s, requiring tunnels several miles long driven through solid rock. But this was only a temporary solution. Finally, the city had to reverse the flow of the Chicago River, using locks and the Illinois Sanitary and Ship Canal, and send the effluent down to the Illinois River. The entire downtown area also had to raised by one story to facilitate gravity sewage flow [Cain, 1977; Galishoff, 1980; Melosi, 2000]. Most cities were making efforts to establish better sources of fresh water and to dispose of sewerage, animal waste, garbage, and trash before the Civil War [Duffy, 1990, chs. 3 and 8; Melosi, Section I, passim].

Nevertheless, public works and public policy were hampered by inadequate knowledge and theories of disease and disease process. Prior to about 1880, disease was frequently attributed to miasmas and vapors arising from filth, to poor moral character or behavior, or to the judgement of God. But late in the 19th century, the "bacteriological revolution" began to inform public works and public health policy and to provide them both with more effective practice and greater legitimacy [Melosi, 2000, ch. 6]. Previous activity was sometimes effective. Bad tasting water, and then the demonstration (by John Snow in London in 1854) that Asiatic cholera was spread by contaminated water, led to the improvement of public water supplies. The miasmatic theories also encouraged waste removal and the construction of sewerage systems. But these policies were adventitious. The early rise in mortality in the urban United States before the Civil War was not thus surprising. The negative mortality externalities of rapid population growth, combined with large numbers of immigrants and the increased movement of goods and people, could not be overcome until more precise knowledge informed practice.[17] The overall American mortality transition and

[17] On the effects of iummigrants on mortality, see Higgs [1979], Meckel [1985], and Preston and Haines [1991], passim. On the "commercial revolution" in antebellum America, see Haines, Craig, and Weiss [2000].

the even more rapid urban mortality transition could only begin in the last decades of the 19th century with the new knowledge.

A pattern was emerging in the late 19th century -- massive public works projects in larger metropolitan areas to provide clean water and proper sewage disposal. But progress was uneven. By 1900, public water supplies were available to 42% of the American population and sewers to 29%, although many households were not connected to the pipes running under the streets and roads in front of their houses. It took longer for filtered water to reach many families. In 1870 almost no water was filtered in the United States. By 1880 about 30,000 persons in urban areas (places over 2,500 persons) were receiving it. The number had grown to 1.86 million in 1900, 10.8 million in 1910, and over 20 million in 1920, about 37% of the whole urban population and a much higher proportion of those living in large cities. In earlier years, almost all these public works were in urban places. In a study of the mortality decline in Philadelphia 1870-1930, Condran and Cheney showed the drastic reduction in typhoid mortality on a ward by ward basis as water filtration was progressively introduced after the turn of the century [Abbott, 1900; Whipple, 1921; Condran and Cheney, 1982].

Progress in public health was not confined to water and sewer systems, though they were among the most effective weapons in the fight to prolong and enhance human life. Simply by reducing the incidence and exposure to disease in any way, overall health, net nutritional status, and resistance to disease was improved. Other areas of public health activity from the late 19th century onward included vaccination against smallpox; use of diphtheria and tetanus antitoxins (from the 1890s); more extensive use of quarantine (as more diseases were identified as contagious); cleaning urban streets and public areas to reduce disease foci; physical examinations for school children; health education; improved child labor and workplace health and safety laws; legislation and enforcement efforts to reduce food adulteration and especially to obtain pure milk; measures to eliminate ineffective or dangerous medications (e.g., the Pure Food and Drug Act of 1906); increased knowledge of and education concerning nutrition; stricter licensing of physicians, nurses, and midwives; more rigorous medical education; building codes to improve heat, plumbing, and ventilation in housing; measures to alleviate air pollution in urban settings; and the creation of state and local boards of health to oversee and administer these programs.

Much of the mortality decline since the Civil War originated in reductions in death from infectious and parasitic diseases, both of the respiratory (usually air-borne) and gastro-intestinal (usually water-borne) types. Reliable cause of death information for larger areas of the nation become available in 1900 with the initiation of the Death Registration Area [Preston, Keyfitz, and Schoen, 1972]. Calculated from these data, the crude death rate declined by 38% between 1900 and 1940, while mortality from all infectious and parasitic diseases was reduced by 88%. Infectious and parasitic diseases declined from 43% of all deaths to only 15%. The decline in mortality from infectious disease actually exceeded that from all causes combined because mortality from chronic, degenerative diseases (cancer, cardiovascular disease) increased. Although this is for the United States as a whole, it is quite consistent with the results found by Crimmins and Condran [1983] that excess urban mortality was attributable to tuberculosis, diarrhea, and a number of other infectious diseases.

CONCLUDING COMMENTS

It is clear that, before about 1920, urban mortality was much in excess of rural mortality. In general, the larger the city, the higher the death rate. A variety of circumstances contributed to the excess mortality of cities: greater density and crowding, leading to the more rapid spread of infection; a higher degree of contaminated water and food; garbage and carrion in streets and elsewhere not properly disposed of; larger inflows of foreign migrants, both new foci of infection and new victims; and also migrants from the countryside who had not been exposed to the harsher urban disease environment. The excess urban mortality was diminishing from the late 19th century onwards, especially as public health measures and improved diet, shelter, and general living standards took effect. The excess in expectation of life at birth for rural white males over those in urban areas was 10 years in 1900. This fell to 7.7 years in 1910, 5.4 years in 1930, and 2.6 years by 1940.

Overall, by 1940 the advantage of rural areas over urban places had virtually disappeared. Indeed now urban areas were healthier, especially for infants. This process had taken a long time. It is likely that cities were relatively insalubrious, even in colonial times. The low level of urbanization early in the nation’s history help make the United States a comparatively low mortality environment. The situation in cities, certainly some of the largest ones, worsened in the antebellum period (1800 to 1860) as a consequence of nationalization and internationalization of the disease environment. Smithian growth from specialization and division of labor cause by improvements in transportation and commercialization had very beneficial effects economically. But the demographic consequences were not so positive. Mortality rose in the rural areas in antebellum America as well, and the decline in heights of native-born white military recruits is a testimony to these deleterious effects [Haines, Craig, and Weiss, 2000].

The overall sustained modern mortality transition began in the 1870s. There is evidence that urban mortality rates, especially in the largest cities, began to decline more rapidly than rural rates from about 1890 or so assisted by significant public works improvements and advances in public health and, eventually, medical practice. By the early decades of the 20th century, other large cities began to accelerate the pace of mortality decline as public works projects for pure water and sanitary sewers came on line for a greater proportion of the city populations. The declines were more pronounced for the younger age groups, including infants after the turn of the century. A cohort process was occurring in which older persons experienced fewer of the benefits to an improved disease environment which had not been prevalent throughout their lives. Thus reductions in infant mortality were more rapid than in e(10). Convergence of rural and urban mortality took place for the white population by the 1920s for infants and by the 1930s for the rest of the population. For the nonwhite (mostly black) population, there were mortality declines, but from a much higher level. And the gap between rural and urban rates was still present by 1940, though rapidly disappearing. The specifically urban mortality transition had become simply the national mortality transition.

Where to go from here? There is a need to look at more disaggregated data (e.g., states, counties, and specific cities). Public health programs need more attention, and cause of death data will have to be considered. But, despite deficiencies in the data, the basic outlines of the American urban mortality transition can be drawn.

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Figure 1.

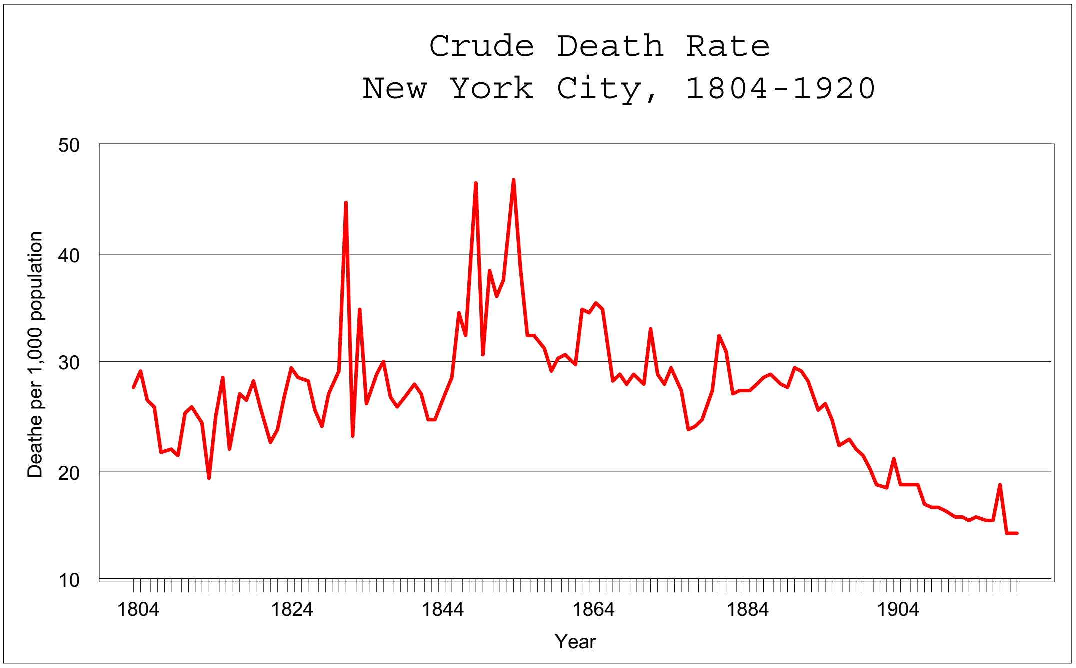


Figure 2.

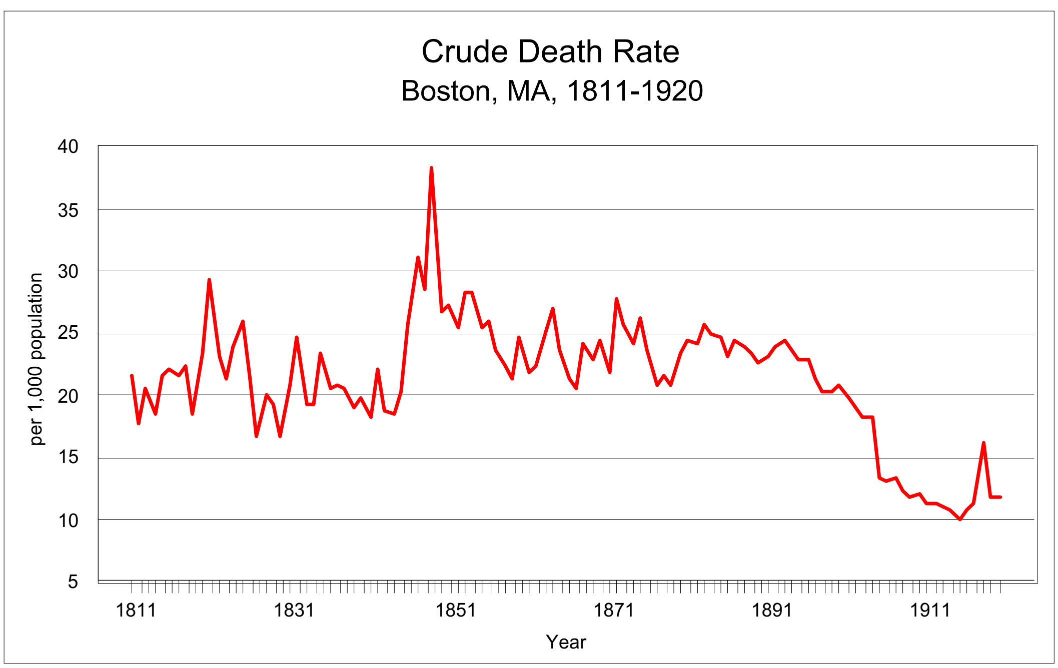


Figure 3.

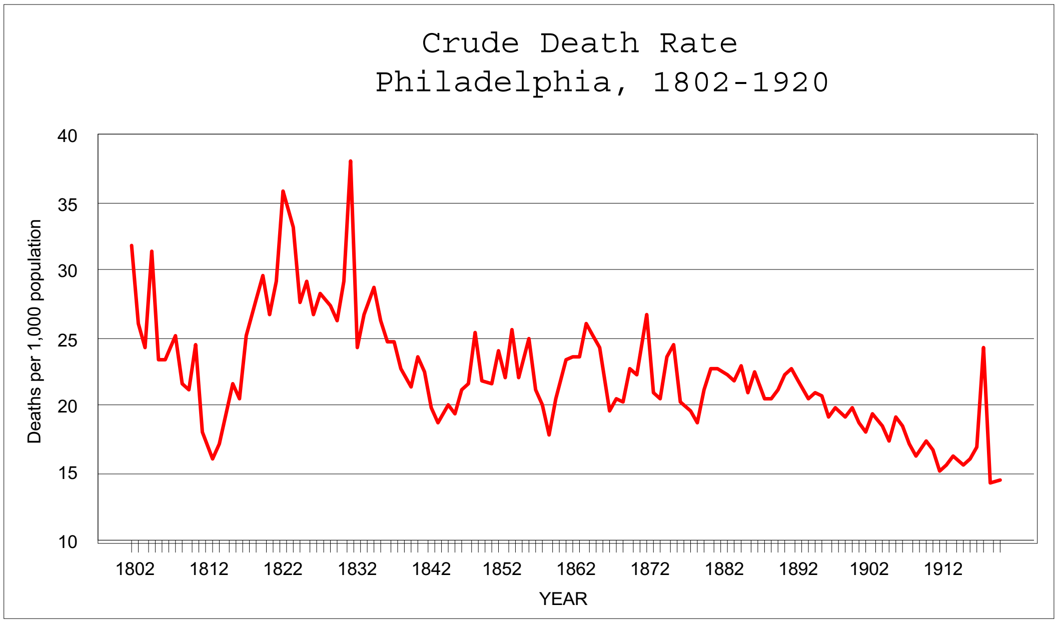


Figure 4.

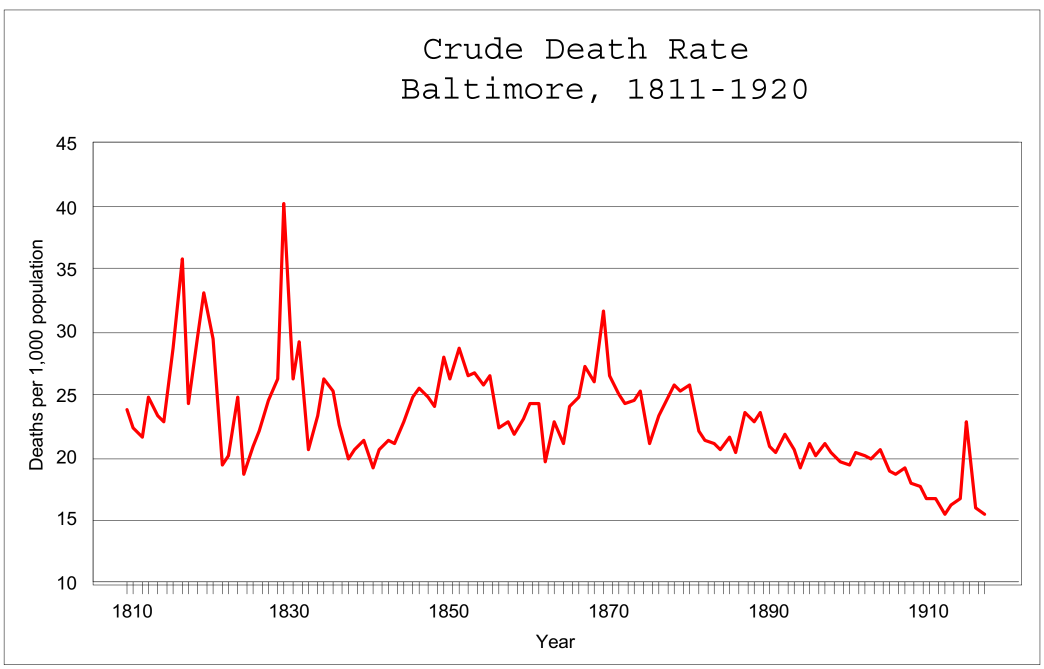
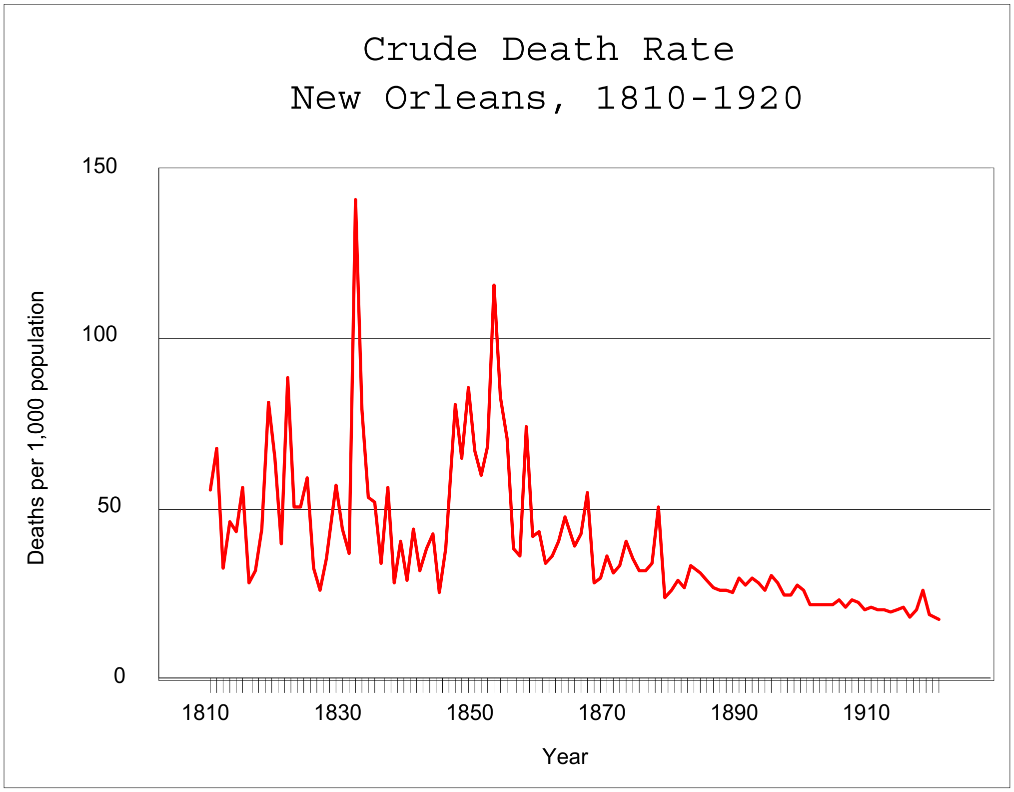


Figure 5.



Crude Death Rate
New Orleans, 1810-1920
150
100
50
0
Deaths per 1,000 population
1810
1830
1850
1870
1890
1910
Year

Table 1. Expectations of Life and Infant Mortality. By Rural-Urban Residence. United States. 1900-1939.

	e(0)				e(10)				IMR			
	Whites		Blacks/Nonwhites		Whites		Blacks/Nonwhites		Whites		Blacks/Nonwhites	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1900/02												
Urban	44.0	47.9			47.5	50.3			151.0	109.0		
Rural	54.0	55.4			54.4	54.4			109.0	89.8		
Ratio	1.227	1.157			1.145	1.082			1.385	1.214		
Difference	10.0	7.5			6.9	4.1			42.0	19.2		
1909/11												
Urban	47.3	51.4			49.1	52.2			133.8	111.2		
Rural	55.1	57.4			54.5	55.5			103.3	85.0		
Ratio	1.165	1.117			1.110	1.063			1.296	1.309		
Difference	7.8	6.0			5.4	3.3			30.5	26.3		
1930												
Urban	56.7	61.0	42.2	45.6	53.1	56.4	40.8	43.1	69.9	55.2	117.6	94.8
Rural	61.0	65.0	50.9	51.8	57.4	59.6	47.7	47.5	55.4	44.2	82.2	68.1
Ratio	1.076	1.066	1.206	1.136	1.081	1.057	1.169	1.102	1.263	1.247	1.430	1.393
Difference	4.3	4.0	8.7	6.2	4.3	3.2	6.9	4.4	14.6	10.9	35.4	26.7
1939												
Cities 100,000+	61.6	66.3	51.0	54.6	55.3	59.4	46.6	49.5	42.7	33.4	76.5	59.8
Other Urban Places	61.4	66.2	46.9	51.0	56.1	60.2	44.3	47.3	52.4	42.3	100.5	79.3
Rural	64.1	67.5	55.2	57.2	58.7	61.3	51.9	52.8	50.4	39.8	80.2	64.8
Ratio (a)	1.044	1.020	1.177	1.122	1.046	1.018	1.172	1.116	1.040	1.063	1.253	1.224
Difference	2.7	1.3	8.3	6.2	2.6	1.1	7.6	5.5	2.0	2.5	20.3	14.5

(a) Ratio to "Other Urban Places."

Source: Table 2.

TABLE 2. Child Mortality and Expectations of Life. United States, 1826-1941.

Source	Region	Period	Sex	Child Mortality [a] q(1)	q(2)	q(5)	e_0	e_{10}	e_{20}
Jaffe & Lourie [1942]	44 New England Towns	1826-35	Total					51.0	42.9
	Salem, MA & New Haven, CT	1826-35	Total					46.0	37.8
	Boston, New York City & Philadelphia	1826-35	Total					35.9	28.0
	Estimated U.S.	1826-35	Total					49.8	41.7
Jacobson [1957]	Massachusetts-Maryland, White	1850	Male	.16064	.21394	.27245	40.4	47.8	40.1
			Female	.13079	.18262	.24122	43.0	48.6	41.7
Meech [1898]	United States, Whites	1830-60	Male	.16195	.21569	.27468	41.0	48.4	40.9
			Female	.13430	.18752	.24769	42.9	48.8	41.4
Kennedy [1853]	Massachusetts	1850	Male				38.3	48.0	40.1
			Female				40.5	47.2	40.2
Elliot [1857]	Massachusetts (166 towns)	1855	Total	.15510	.22670	.28540	39.8	47.1	39.9
Haines	Massachusetts	1855-56	Total	.12994		.24262	44.2	49.8	42.2
Haines	Massachusetts	1859-61	Male	.14246		.24846	43.5	49.6	41.9
			Female	.13643		.22466	45.1	52.8	42.4
Vinovskis [1972]	Massachusetts	1859-61	Male			.22646	46.4	51.6	44.0
			Female			.19193	47.3	50.1	43.0
Haines [1977]	Seven New York Counties	1850-65	Male	.14655	.18067	.21268	45.9	49.2	
			Female	.12389	.15821	.19105	48.9	51.4	
			Total	.13549	.16972	.20213	47.4	50.3	
Haines [1979]	United States [U.S. Model]	1850	Male	.24092	.28396	.32195	37.2	46.2	38.4
			Female	.21712	.25937	.29845	39.4	47.5	39.8
		1860	Male	.20210	.23979	.27361	41.6	48.3	40.3
			Female	.19153	.23041	.26684	42.1	48.7	40.9
		1870	Male	.19210	.22788	.26007	43.0	49.2	41.1
			Female	.17724	.21234	.24531	44.9	50.6	42.6
		1880	Male	.22015	.25997	.29538	39.7	47.5	39.6
			Female	.22980	.27175	.31019	39.1	48.0	40.3
		1890	Male	.16334	.19744	.22875	44.8	49.1	41.0
			Female	.15765	.19232	.22546	45.6	50.0	41.9
		1900	Male	.13356	.16480	.21252	47.1	49.4	41.1
			Female	.12476	.15572	.18611	48.4	50.5	42.3
	United States, White [U.S. Model]	1850	Male	.22829	.26997	.30697	38.4	46.6	38.8
			Female	.20596	.24684	.28486	40.6	51.4	43.9
		1860	Male	.18774	.22351	.25579	43.2	49.1	41.0
			Female	.17515	.21158	.24598	44.1	49.6	41.7
		1870	Male	.18513	.21955	.25056	44.1	49.9	41.8
			Female	.16633	.19968	.23114	46.4	51.4	43.3
		1880	Male	.21436	.25326	.28794	40.4	47.9	40.0

			Female	.21526	.25553	.29268	40.6	48.6	40.9
		1890	Male	.15675	.18926	.21914	46.0	50.0	41.7
			Female	.14490	.17722	.20829	47.4	51.0	42.8
		1900	Male	.12784	.15730	.18497	48.5	50.4	42.0
			Female	.11206	.14012	.16781	50.7	51.9	43.5
Fogel [1986]	United States,	1850-60	Male					46.7	
Pope [1992]	United States [Genealogies]	1820-29	Male						43.3
			Female						44.9
		1830-39	Male						44.6
			Female						44.6
		1840-49	Male						41.5
			Female						37.1
		1850-59	Male						40.8
			Female						39.5
		1860-69	Male						41.2
			Female						42.2
		1870-79	Male						44.3
			Female						42.2
		1880-89	Male						45.8
			Female						42.9
Haines	Massachusetts	1864-66	Male	.16002	.22431	.28639	38.4	45.8	38.7
			Female	.14267	.20352	.26706	41.6	48.7	41.8
Haines	Massachusetts	1869-71	Male	.16675	.21849	.26214	42.6	49.3	41.5
			Female	.16090	.19413	.23881	44.4	49.8	42.5
Haines	Massachusetts	1874-76	Male	.17941	.24772	.29812	40.0	48.9	41.3
			Female	.15449	.21967	.27050	41.8	49.4	42.2
Haines	Massachusetts	1879-81	Male	.17086	.22341	.27712	41.7	49.5	41.6
			Female	.16535	.19633	.25045	43.3	49.6	42.3
Billings [1886]	Massachusetts	1878-82	Male	.18080	.23250	.28342	41.7	49.9	42.2
			Female	.15257	.20245	.25408	43.5	50.0	42.8
Billings [1886]	New Jersey	1879-80	Male	.15153	.19398	.24132	45.6	51.6	43.3
			Female	.13121	.16939	.21217	48.0	52.5	44.5
Haines	Massachusetts	1884-86	Male	.16923	.22925	.27210	41.9	49.0	41.1
			Female	.14507	.20531	.24668	43.9	49.8	42.2
Haines	Massachusetts	1889-91	Male	.17615	.23742	.27354	41.8	49.0	41.1
			Female	.14957	.20973	.24613	44.0	49.9	42.2
Glover [1921]	Massachusetts	1890	Male	.16777	.20851	.25322	42.5	48.4	40.7
			Female	.14755	.18738	.23415	44.5	49.6	42.0
Abbott [1898]	Massachusetts	1893-97	Male	.17233	.20726	.24234	44.1	49.3	41.2
			Female	.14699	.18115	.21593	46.6	50.7	42.8
Haines	Massachusetts	1893-97	Male	.17466	.23913	.27331	42.1	49.2	41.0
			Female	.14660	.21036	.24417	44.8	50.6	42.7
Glover [1921]	DRA, Total	1900-02	Male	.13574	.16614	.19452	47.9	50.4	42.0
			Female	.11267	.14092	.16881	50.7	51.9	43.6
			Total	.12448	.15383	.18196	49.2	51.1	42.8
	DRA, Whites	1900-02	Male	.13345	.16331	.19136	48.2	50.6	42.2
			Female	.11061	.13832	.16574	51.1	52.2	43.8

	DRA, Blacks	1900-02	Male	.25326	.31098	.35615	32.5	41.9	35.1
			Female	.21475	.26990	.31944	35.0	43.0	36.9
	DRA, Urban, Whites	1900-02	Male	.15097	.18683	.22128	44.0	47.5	39.1
			Female	.12545	.15883	.19195	47.9	50.3	41.9
	DRA, Rural, Whites	1900-02	Male	.10900	.13065	.15043	54.0	54.4	46.0
			Female	.08979	.10967	.12983	55.4	54.4	46.1
Preston/ Haines [1991]	U.S., Total	1895/00	Male	.12973	.15836	.18522	49.7	50.6	42.1
			Female	.11029	.13930	.16706	51.6	52.8	44.5
			Total	.12047	.14906	.17636	50.1	51.6	43.3
	U.S., Whites	1895/00	Male	.11988	.14569	.16990	50.4	51.4	42.9
			Female	.10120	.12702	.15174	53.4	53.7	45.3
			Total	.11076	.13658	.16104	51.8	52.5	44.1
	U.S., Blacks	1895/00	Male	.18346	.22656	.26698	40.4	46.2	38.3
			Female	.15657	.20040	.24234	43.3	48.3	40.7
			Total	.17034	.21380	.25496	41.8	47.2	38.5
Haines/ Preston [1997]	U.S., Total	1905/10	Male	.11300	.13687	.15925	51.5	52.0	43.4
			Female	.09488	.11840	.14121	54.7	54.4	45.9
			Total	.10416	.12786	.14689	53.1	53.2	44.7
	U.S., Whites	1905/10	Male	.10497	.12660	.14689	53.0	52.8	44.1
			Female	.08757	.10846	.12911	56.2	55.3	46.7
			Total	.09648	.11775	.13822	54.6	54.0	45.4
	U.S., Blacks (West Model)	1905/10	Male	.15402	.19009	.22392	44.7	48.5	40.4
			Female	.13051	.16682	.20157	47.7	50.8	42.8
			Total	.14255	.17874	.21302	46.2	49.6	41.6
	U.S., Blacks (Far East Model)	1905/10	Male	.12714	.15555	.18980	41.8	42.6	34.6
			Female	.10946	.13808	.17068	44.6	44.6	36.6
			Total	.11852	.14702	.18047	43.2	43.6	35.6
Glover [1921]	DRA, Total	1909-11	Male	.12495	.15016	.17282	49.9	51.1	42.5
			Female	.10377	.12743	.14883	53.2	53.3	44.7
			Total	.11462	.13908	.16113	51.5	52.2	43.5
	DRA, Whites	1909-11	Male	.12326	.14799	.17028	50.2	51.3	42.7
			Female	.10226	.12545	.14651	53.6	53.6	44.9
	DRA, Blacks	1909-11	Male	.21935	.27155	.31411	34.0	40.6	33.5
			Female	.18507	.23303	.27232	37.7	42.8	36.1
	DRA, Urban Whites	1909-11	Male	.13380	.16247	.18815	47.3	49.1	40.5
			Female	.11123	.13831	.16266	51.4	52.2	43.5
	DRA, Rural Whites	1909-11	Male	.10326	.12105	.13777	55.1	54.5	45.9
			Female	.08497	.10119	.11679	57.4	55.5	46.9
NCHS [1997]	DRA, Whites	1919-21	Male	.08025	.09815	.11158	56.3	54.2	45.6
			Female	.06392	.07757	.09279	58.5	55.2	46.5
	DRA, Blacks	1919-21	Male	.10501	.12782	.14805	47.1	46.0	38.4
			Female	.08749	.10851	.12851	46.9	44.5	37.2
	DRA, Whites	1929-31	Male	.06232	.07163	.08262	59.1	55.0	46.0
			Female	.04963	.05798	.06784	62.7	57.6	48.5
	DRA, Blacks	1929-31	Male	.08732	.10245	.11588	47.6	44.3	36.0
			Female	.07204	.08538	.09815	49.5	45.3	37.2
Dublin, et al. [1949]									
	DRA, Urban Whites	1930	Male	.06994			56.7	53.1	44.2
			Female	.05517			61.0	56.4	47.4

	DRA, Rural Whites	1930	Male	.05537			62.1	57.4	48.3
			Female	.04423			65.1	59.6	50.4
	DRA, Urban Nonwhites	1930	Male	.11756			42.2	40.8	33.0
			Female	.09482			45.6	43.1	35.3
	DRA, Rural Nonwhites	1930	Male	.08220			50.9	47.7	39.2
			Female	.06808			51.8	47.5	39.3
NCHS [1997]	U.S., Total	1939-41	Male	.05238	.05762	.06376	61.6	56.1	46.9
			Female	.04152	.04621	.05152	65.9	59.7	50.4
			Total	.04710	.05206	.05780	63.6	57.8	48.5
	U.S., Whites	1939-41	Male	.04812	.05276	.05850	62.8	57.0	47.8
			Female	.03789	.04204	.04691	67.3	60.8	51.4
	U.S., Blacks	1939-41	Male	.08238	.09088	.09918	52.3	48.3	39.5
			Female	.06584	.07328	.08094	55.6	50.8	42.0
Dublin, et al. [1949]									
	U.S., Cities 100,000+ Whites	1939	Male	.04270			61.6	55.3	46.0
			Female	.03340			66.3	59.4	49.9
	U.S., Other Urban Places Whites	1939	Male	.05240			61.4	56.1	47.0
			Female	.04230			66.2	60.2	50.8
	U.S., Rural Areas Whites	1939	Male	.05040			64.1	58.7	49.5
			Female	.03980			67.5	61.3	51.9
	U.S., Cities 100,000+ Nonwhites	1939	Male	.07650			51.0	46.6	38.0
			Female	.05980			54.6	49.5	41.0
	U.S., Other Urban Places Nonwhites	1939	Male	.10050			46.9	44.3	35.8
			Female	.07930			51.0	47.3	38.9
	U.S., Rural Areas Nonwhites	1939	Male	.08020			55.2	51.9	43.0
			Female	.06480			57.2	52.8	44.0
<u>Selected Cities</u>									
Haines & Higgins [1997]	Rochester, NY	1838-42	Male	.12727		.29258	40.2	46.0	38.0
			Female	.11340		.22919	41.8	46.3	38.7
		1853-57	Male	.14534		.23457	43.9	48.7	40.6
			Female	.11883		.19973	47.0	49.9	42.1
Haines	Suffolk Co., MA (Boston)	1855-56	Total	.17384		.34455	34.5	44.4	37.0
Haines	Suffolk Co., MA (Boston)	1859-61	Male	.18027		.34388	36.3	44.4	36.7
			Female	.15940		.29495	39.1	46.8	39.0
Haines	Suffolk Co., MA (Boston)	1864-66	Male	.19414	.28120	.35732	32.3	41.7	34.4
			Female	.19747	.28115	.35300	35.6	46.8	39.3
Haines	Suffolk Co., MA (Boston)	1874-76	Male	.20041	.29428	.35731	34.0	45.1	37.5
			Female	.18387	.27161	.33309	36.5	47.1	39.9
Billings [1886]	Boston, Whites	1879-80	Male	.21739	.28518	.34218	37.0	47.5	39.6
			Female	.18873	.25365	.30823	39.1	48.4	40.7
Haines	Suffolk Co., MA (Boston)	1884-86	Male	.20160	.28245	.33710	34.8	44.0	36.3
			Female	.17732	.25915	.31453	37.1	45.9	38.4

Haines	Suffolk Co., MA (Boston)	1894-96	Male	.17870	.26501	.31567	36.0	44.0	36.1
			Female	.15023	.23576	.28472	39.8	47.3	39.5
Glover [1921]	Boston	1900-02	Male	.15736	.19875	.24002	41.6	46.0	37.8
			Female	.13548	.16983	.21017	45.1	48.5	40.2
Glover [1921]	Boston	1909-11	Male	.13527	.16333	.19050	46.0	47.7	39.1
			Female	.11330	.13851	.16181	50.3	50.9	42.4
Haines	Suffolk Co., MA (Boston)	1929-31	Male	.07230		.10094	54.6	51.5	42.5
			Female	.07979		.08220	58.4	54.3	45.2
Haines	Suffolk Co., MA (Boston)	1939-41	Male	.0		.10094	54.6	51.5	42.5
			Female	.07979		.08220	58.4	54.3	45.2
Haines	Philadelphia	1860-61	Total	.18531		.32837	37.3	47.9	40.1
	Philadelphia	1869-71	Total	.21300		.33249	36.2	45.7	38.0
	Philadelphia	1879-81	Total	.21915		.32047	38.1	46.8	39.0
	Philadelphia	1889-91	Total	.19668		.29722	39.5	47.6	39.7
Glover [1921]	Philadelphia	1900-02	Male	.15027	.18978	.23006	42.5	46.3	38.1
			Female	.12741	.16369	.20232	46.2	49.1	40.9
Glover [1921]	Philadelphia	1909-11	Male	.14174	.17456	.20558	45.5	48.1	39.5
			Female	.11926	.14959	.17796	49.6	51.2	42.6
Haines	Philadelphia	1919-21	Total	.08540		.12526	52.7	51.0	42.5
	Philadelphia	1929-31	Total	.06304		.08693	57.3	53.2	44.2
Billings [1886]	New York City	1878-81	Male	.26278	.35464	.42751	29.0	42.4	34.4
			Female	.22411	.31513	.38744	32.8	45.3	37.3
Billings [1886]	New York City, Whites	1879-80	Male	.23421	.32245	.38085	33.3	44.9	36.6
			Female	.20427	.28527	.34167	36.8	46.9	38.6
Billings [1886]	Brooklyn, Whites	1879-80	Male	.19477	.27036	.33101	37.5	48.1	39.8
			Female	.16424	.24336	.30545	39.7	49.1	41.0
Glover [1921]	New York City	1900-02	Male	.15673	.20308	.24435	40.6	44.9	36.4
			Female	.13298	.17564	.21542	44.9	48.2	39.7
Glover [1921]	New York City	1909-11	Male	.13186	.16799	.19907	45.3	47.4	38.7
			Female	.11405	.14762	.17708	49.5	50.9	42.2
Billings [1886]	Chicago, Whites	1879-80	Male	.20526	.27950	.34394	38.1	50.6	42.7
			Female	.15107	.22919	.29958	41.3	51.6	43.8
Glover [1921]	Chicago	1900-02	Male	.12010	.15142	.18191	46.3	47.7	39.5
			Female	.09762	.12764	.15676	50.8	55.0	42.9
Glover [1921]	Chicago	1909-11	Male	.13066	.16079	.18980	45.9	51.5	39.0
			Female	.10431	.13196	.15959	51.7	52.4	43.8

[a] q(1) is the probability of dying before reaching age 1. It is the infant mortality rate. q(2) and q(5) are the probabilities of dying before reaching ages 2 and 5, respectively. e_0, e_{10}, and e_{20} are the expectations of life at birth and at ages 10 and 20.

Source: Jaffe & Lourie [1942]. Jacobson [1957]. Meech [1898]. Pope [1992]. Meeker [1972], Table 1. Glover [1921]. Haines [1977, 1979a, 1998]. Preston & Haines [1991], ch. 2. Haines and Preston [1997]. Vinovskis [1972]. Fogel [1986], Table 3. U.S. Bureau of the Census [1886] (Billings). Abbott [1898]. NCHS [1997]. Dublin, Lotka, and Spegelman [1949]. Various Massachusetts, New York, and Philadelphia vital statistics and census data (Haines).

Table 3. Death Rates in the Rural and Urban Parts of Registration States, 1890 to 1940. (1)
(Rates per 1,000 population per annum)

Area/Date	Overall Death Rates			Infant Mortality Rates(2) (Under 1 year)			Child Death Rates (1-4 years)		
	Rural	Urban	Ratio of Urban to Rural	Rural	Urban	Ratio of Urban to Rural	Rural	Urban	Ratio Urban to Rural
1890									
Connecticut	19.4	23.1	1.19	173.1	233.9	1.35	21.3	33.4	1.56
Massachusetts	17.5	21.0	1.20	138.3	247.9	1.79	17.5	31.3	1.79
New Hampshire	20.3	20.9	1.03	168.8	290.4	1.72	18.2	37.1	2.03
New Jersey	19.6	26.0	1.33	211.9	346.9	1.64	20.7	41.0	1.98
New York	16.1	25.8	1.60	115.5	324.5	2.81	16.2	38.9	2.39
Rhode Island	23.3	23.7	1.02	233.4	300.5	1.29	39.3	37.4	0.95
Vermont	18.4	20.5	1.11	138.9	248.6	1.79	16.7	18.9	1.13
Total (7 states)	18.6	24.6	1.32	162.8	306.1	1.88	19.3	37.4	1.94
All Regis. States	18.8	24.7	1.31	155.4	319.0	2.05	19.6	37.5	1.91
1900									
Connecticut	16.9	17.0	1.01	128.9	148.9	1.15	13.4	17.5	1.31
Massachusetts	17.1	17.9	1.05	118.1	170.7	1.45	13.8	22.7	1.65
New Hampshire	17.5	18.8	1.08	131.4	187.4	1.43	13.4	28.7	2.15
New Jersey	15.5	18.8	1.21	129.1	165.9	1.29	15.6	26.4	1.69
New York	15.2	19.2	1.26	96.0	163.4	1.70	11.4	28.2	2.48
Rhode Island	18.8	19.2	1.02	166.3	182.1	1.10	22.6	28.3	1.25
Vermont	16.9	17.6	1.05	103.7	160.6	1.55	10.6	18.4	1.72
Total (7 states)	16.0	18.7	1.17	112.0	165.4	1.48	13.0	26.1	2.00
All Regis. States	15.4	18.6	1.21	108.7	165.8	1.52	12.9	25.5	1.97
1910									
Connecticut	15.0	15.9	1.06						
Massachusetts	16.1	16.0	0.99						
New Hampshire	17.1	17.5	1.02						
New Jersey	14.3	16.1	1.13						
New York	16.0	16.2	1.01						
Rhode Island	16.5	17.2	1.05						
Vermont	15.8	17.2	1.09						
Total (7 states)	15.7	16.2	1.03						
All Regis. States	13.4	15.9	1.18						

Table 3 (cont.)

1920									
Connecticut	12.7	13.8	1.09		88.0	92.8	1.05		
Massachusetts	14.2	13.7	0.97		82.9	92.3	1.11		
New Hampshire	15.4	15.0	0.98		78.3	97.1	1.24		
New Jersey	12.8	13.0	1.02		80.8	87.1	1.08		
New York	15.2	13.4	0.88		78.2	88.1	1.13		
Rhode Island	12.8	14.6	1.14		82.1	93.0	1.13		
Vermont	15.5	17.4	1.12		92.1	117.5	1.28		
Total (7 states)	14.4	13.5	0.94		81.0	89.6	1.11		
All Regis. States	11.9	14.1	1.18		80.5	91.0	1.13		
1930									
Connecticut	9.7	11.2	1.16		54.3	56.5	1.04		
Massachusetts	11.9	11.5	0.97		65.4	59.5	0.91		
New Hampshire	13.7	13.4	0.98		21.9	63.5	2.91		
New Jersey	11.1	10.6	0.96		57.4	56.2	0.98		
New York	12.8	11.4	0.89		59.3	58.7	0.99		
Rhode Island	11.2	11.7	1.04		68.4	61.1	0.89		
Vermont	12.7	14.7	1.15		63.8	68.5	1.07		
Total (7 states)	12.0	11.3	0.94		57.9	58.5	1.01		
All Regis. States	10.4	12.3	1.18		66.3	62.8	0.95		
1940									
Connecticut	7.8	11.9	1.53	32.9	34.2	1.04	0.7	2.3	3.14
Massachusetts	11.1	12.0	1.08	33.9	37.8	1.11	1.3	2.3	1.79
New Hampshire	12.6	12.8	1.02	39.8	40.1	1.01	2.2	3.0	1.40
New Jersey	10.8	10.8	1.00	39.9	34.8	0.87	1.3	2.3	1.81
New York	12.2	10.8	0.89	42.4	36.3	0.86	1.8	2.0	1.16
Rhode Island	9.8	11.4	1.17	40.5	38.1	0.94	0.8	2.5	3.04
Vermont	12.2	16.3	1.34	44.4	46.4	1.04	1.9	2.5	1.30
Total (7 states)	11.3	11.2	0.99	40.6	36.4	0.90	1.5	2.2	1.42
All States	9.5	12.2	1.29	50.5	43.8	0.87	2.6	3.4	1.33

(1) Urban is defined in this table as places with population of 10,000 & over. The exceptions are 1890 and 1900, where the urban thresholds were 5,000 and 8,000 population respectively. Deaths for 1890 adjusted for underregistration according to Condran and Crimmins (1980).
(2) Infant deaths (below one year of age) are related to births. Births were estimated for 1890 and 1900 in the census.

Source: U.S. Bureau of the Census (1896), Table 1; (1902), Table 19. Various issues of MORTALITY STATISTICS and BIRTH STATISTICS OF THE UNITED STATES (for 1910-1930). VITAL STATISTICS OF THE UNITED STATES (for 1940). Linder and Grove (1947), Table IV.

Table 4. Mortality Index by Residence. United States, 1900 and 1910.

Residence	1900 Mort. Index	1900 Total Women	1900 Total CEB	1900 Implied q(5)	1910 Mort. Index	1910 Total Women	1910 Total CEB	1910 Implied q(5)	% Decline in q(5) 1900/10	Ratio to Rural 1900	Ratio to Rural 1910
Total Population	1.009	13429	41386	0.19287	1.000	46766	172938	0.17800	7.71	1.09	1.06
Urban	1.126	6302	17292	0.21534	1.063	24528	81507	0.18921	12.13	1.22	1.13
Rural	0.923	7023	23742	0.17647	0.942	22172	91132	0.16768	4.98	1.00	1.00
Top 10 Cities	1.144	1765	4934	0.21882	1.168	6294	21275	0.20790	4.99	1.24	1.24
Other Cities 25,000+	1.281	1781	4874	0.24497	1.070	8454	27277	0.19046	22.25	1.39	1.14
Cities 5,000-24,999	1.099	1408	3763	0.21019	1.032	5069	16921	0.18370	12.61	1.19	1.10
Cities 1,000-4,999	0.927	1348	3721	0.17723	0.942	4711	16034	0.16768	5.39	1.00	1.00
Top 10 Cities (1900)											
New York City	1.242	667	1932	0.23736	1.218	2524	8828	0.21680	8.66	1.35	1.29
Chicago	1.096	309	820	0.20947	1.089	1111	3714	0.19384	7.46	1.19	1.16
Philadelphia	1.148	229	590	0.21939	1.316	795	2754	0.23425	-6.77	1.24	1.40
St. Louis	0.960	106	324	0.18345	1.016	357	1117	0.18085	1.42	1.04	1.08
Boston	1.327	85	211	0.25369	1.125	334	1114	0.20025	21.07	1.44	1.19
Baltimore	1.256	101	314	0.24008	1.271	284	1004	0.22624	5.76	1.36	1.35
Cleveland	0.576	79	204	0.11018	0.978	286	947	0.17408	-58.00	0.62	1.04
Buffalo	1.030	68	195	0.19700	1.003	211	688	0.17853	9.37	1.12	1.06
San Francisco	0.999	51	114	0.19100	0.861	199	541	0.15326	19.76	1.08	0.91
Cincinnati	1.107	70	230	0.21172	1.200	193	568	0.21360	-0.89	1.20	1.27

Source: 1900: Preston and Haines (1991), Table 3.1 1910: Preston, Ewbank, & Hereward (1994), Table 3.2. For an explanation of the child mortality index, see text.

Table 5. Selected Life Table Values. Massachusetts & Boston/Suffolk County. 1850-1940.

	Massachusetts			Suffolk Co./Boston (1)			Ratio Boston/Massachusetts		
Dates	IMR	e(0)	e(10)	IMR	e(0)	e(10)	IMR	e(0)	e(10)
1849/51									
Males	137.6	42.3	49.8	181.9	28.2	39.3	1.32	0.67	0.79
Females	122.3	43.3	49.0	167.6	30.9	41.2	1.37	0.71	0.84
Both Sexes	130.2	42.9	49.6	174.9	29.5	40.2	1.34	0.69	0.81
1854/56									
Both Sexes	130.7	43.8	49.5	173.6	34.1	43.6	1.33	0.78	0.88
1859/61									
Males	142.4	43.5	49.6	180.3	36.3	44.5	1.27	0.83	0.90
Females	123.7	45.1	49.7	159.4	39.1	46.8	1.29	0.87	0.94
Both Sexes	133.4	44.3	49.7	170.1	37.7	45.7	1.28	0.85	0.92
1864/66									
Males	160.0	38.4	45.8	194.1	32.3	41.7	1.21	0.84	0.91
Females	142.7	41.6	48.7	197.5	35.6	46.8	1.38	0.86	0.96
Both Sexes	151.8	40.1	47.3	195.8	34.0	44.4	1.29	0.85	0.94
1874/76									
Males	179.4	40.0	48.9	200.4	34.0	45.1	1.12	0.85	0.92
Females	154.5	41.8	49.4	183.9	36.5	47.1	1.19	0.87	0.95
Both Sexes	167.3	40.8	49.1	192.3	35.3	46.1	1.15	0.87	0.94
1879/81									
Males	170.8	41.7	49.5	196.0	35.9	45.6	1.15	0.86	0.92
Females	145.7	43.3	49.6	173.1	37.9	46.9	1.19	0.88	0.95
Both Sexes	158.5	42.5	49.6	184.8	36.9	46.3	1.17	0.87	0.93
1884/86									
Males	169.2	41.9	49.0	201.6	34.8	44.0	1.19	0.83	0.90
Females	145.1	43.9	49.8	177.3	37.1	45.9	1.22	0.85	0.92
Both Sexes	157.4	42.9	49.4	189.8	36.0	45.0	1.21	0.84	0.91
1894/96									
Males	174.7	42.1	49.2	178.7	36.0	44.0	1.02	0.86	0.89
Females	146.6	44.8	50.6	150.2	39.8	47.3	1.02	0.89	0.93
Both Sexes	170.0	43.5	49.9	164.8	37.8	45.6	0.97	0.87	0.91
1900/02									
Males	158.8	46.1	50.2	157.4	41.6	46.0	0.99	0.90	0.92
Females	131.2	49.4	52.1	135.5	45.1	48.5	1.03	0.91	0.93
1904/06									
Males	151.2	46.6	50.5	156.9	42.3	46.7	1.04	0.91	0.92
Females	122.8	50.4	52.7	124.5	46.9	49.8	1.01	0.93	0.94
Both Sexes	137.4	48.5	51.6	141.2	44.6	48.2	1.03	0.92	0.93
1909/11									
Males	137.1	49.3	51.1	135.3	46.0	47.7	0.99	0.93	0.93
Females	113.0	53.1	53.6	113.3	50.3	50.9	1.00	0.95	0.95
1914/16									
Males	113.0	51.2	51.4	108.8	47.9	48.1	0.96	0.94	0.94
Females	91.7	55.2	54.3	90.7	52.3	51.8	0.99	0.95	0.95
Both Sexes	102.6	53.2	52.9	100.0	50.0	49.9	0.97	0.94	0.94
1929/31									
Males	65.4	58.9	55.0	72.3	54.6	51.5	1.11	0.93	0.94
Females	52.4	62.3	57.5	55.8	58.4	54.3	1.06	0.94	0.94
Both Sexes	59.1	60.6	56.3	64.2	56.5	52.9	1.09	0.93	0.94

1939/41									
Males	41.4	63.2	56.8	45.2	60.8	54.5	1.09	0.96	0.96
Females	31.7	67.5	60.5	33.2	65.7	58.7	1.05	0.97	0.97
Both Sexes	36.7	65.4	58.7	39.2	63.2	56.6	1.07	0.97	0.96

(1) City of Boston for 1900/02 and 1909/11. Otherwise, Suffolk County.

Source: 1900/02 & 1909/11, Glover (1921). Other life tables calculated from the state and federal censuses of Massachusetts and the vital statistics of Massachusetts.

Table 6. Infant Mortality Rate, by Residence & Race. Birth Registration Area, 1915-1932. United States, 1933-1940.

	Total			Cities 10,000 & Over			Cities 2,500 TO 9,999			Rural			Ratio of Urban to Rural		
Year	Total	White	Nonwhite	Total	White	Nonwhite	Total	White	Nonwhite	Total	White	Nonwhite	Total	White	Nonwhite
1915	99.9	98.6	181.2	103.3	101.6	181.0				94.4	93.8	182.2	1.09	1.08	0.99
1916	101.0	99.0	184.9	103.7	101.8	176.6				96.7	94.6	202.8	1.07	1.08	0.87
1917	93.8	90.5	150.7	99.6	96.4	185.3				87.9	84.3	133.5	1.13	1.14	1.39
1918	100.9	97.4	161.2	108.1	104.7	196.8				93.7	89.8	142.8	1.15	1.17	1.38
1919	86.6	83.0	130.5	89.3	86.3	147.6				84.1	79.7	122.8	1.06	1.08	1.20
1920	85.8	82.1	131.7	91.0	87.5	158.5				80.5	76.3	118.1	1.13	1.15	1.34
1921	75.6	72.5	108.5	77.6	74.7	128.2				73.6	70.1	99.8	1.05	1.07	1.29
1922	76.2	73.2	110.0	79.9	77.3	127.0				72.4	68.7	101.7	1.10	1.12	1.25
1923	77.1	73.5	117.4	78.2	74.5	138.1				76.0	72.3	106.0	1.03	1.03	1.30
1924	70.8	66.8	112.9	72.4	68.7	126.6				69.2	64.7	104.9	1.05	1.06	1.21
1925	71.7	68.3	110.8	73.0	69.4	125.0				70.3	67.2	100.5	1.04	1.03	1.24
1926	73.3	70.0	111.8	74.2	70.5	127.2				72.4	69.4	100.8	1.02	1.02	1.26
1927	64.6	60.6	100.1	65.0	61.0	113.1				64.1	60.3	92.3	1.01	1.01	1.23
1928	68.7	64.0	106.2	69.2	64.6	121.3				68.3	63.4	98.5	1.01	1.02	1.23
1929	67.6	63.2	102.2	66.2	61.9	114.4				68.8	64.4	95.9	0.96	0.96	1.19
1930	64.6	59.6	102.4	62.8	58.4	110.7				66.3	60.9	97.9	0.95	0.96	1.13
1931	61.6	56.7	95.6	61.0	56.4	105.4				62.2	57.1	90.2	0.98	0.99	1.17
1932	57.6	53.3	86.2	56.7	52.5	95.5				58.4	54.1	81.3	0.97	0.97	1.17
1933	58.1	52.8	91.3	57.1	52.4	97.8	59.6	54.5	107.2	58.8	52.9	85.8	0.97	0.99	1.14
1934	60.1	54.5	94.4	58.1	53.4	99.2	62.4	57.7	102.9	61.5	55.0	90.7	0.94	0.97	1.09
1935	55.7	51.9	83.2	54.0	50.5	89.5	58.6	56.1	91.9	57.0	52.4	79.1	0.95	0.96	1.13
1936	57.1	52.9	87.6	55.3	51.3	96.8	60.5	57.4	107.1	58.4	53.6	81.0	0.95	0.96	1.19
1937	54.4	50.3	83.2	52.0	48.3	89.8	57.7	54.2	105.7	56.5	51.9	77.2	0.92	0.93	1.16
1938	51.0	47.1	79.1	47.9	44.5	82.9	55.3	52.0	103.0	53.7	49.1	74.5	0.89	0.91	1.11
1939	48.0	44.3	74.2	45.3	42.2	75.8	51.6	48.5	94.6	50.5	45.9	71.1	0.90	0.92	1.07
1940	47.0	43.2	73.8	43.8	40.7	75.5	51.0	48.1	89.4	50.3	45.6	70.7	0.87	0.89	1.07

Source: Birth Statistics of the United States, 1915-1936. Vital Statistics of the U.S., 1937-1940.

Table A-1. Growth of Birth- and Death-Registration Area: 1900 to 1933
(Coterminous United States, midyear populations)

		Birth Registration Area			Death Registration Area		
Year	Total U.S. Population 000s	Population 000s	% of Total	Number of States(1)	Population 000s	% of Total	Number of States(1)
1900	76,094				19,965	26.2	11
1901	77,585				20,237	26.1	11
1902	79,160				20,583	26.0	11
1903	80,632				20,943	26.0	11
1904	82,165				21,332	26.0	11
1905	83,820				21,768	26.0	11
1906	85,437				33,782	39.5	16
1907	87,000				34,553	39.7	16
1908	88,709				38,635	43.6	18
1909	90,492				44,224	48.9	19
1910	92,407				47,470	51.4	21
1911	93,868				53,930	57.5	23
1912	95,331				54,848	57.5	23
1913	97,227				58,157	59.8	24
1914	99,118				60,963	61.5	25
1915	100,549	31,097	30.9	11	61,895	61.6	25
1916	101,966	32,944	32.3	12	66,971	65.7	27
1917	103,266	55,198	53.5	21	70,235	68.0	28
1918	103,203	55,154	53.4	21	79,008	76.6	31
1919	104,512	61,212	58.6	23	83,158	79.6	34
1920	106,466	63,597	59.7	24	86,079	80.9	35
1921	108,541	70,807	65.2	28	87,814	80.9	35
1922	110,055	79,561	72.3	31	92,703	84.2	38
1923	111,950	81,072	72.4	31	96,788	86.5	39
1924	114,113	87,000	76.2	34	99,318	87.0	40
1925	115,832	88,295	76.2	34	102,032	88.1	41
1926	117,399	90,401	77.0	36	103,823	88.4	42
1927	119,038	104,321	87.6	41	107,085	90.0	43
1928	120,501	113,636	94.3	45	113,636	94.3	45
1929	121,770	115,317	94.7	47	115,317	94.7	47
1930	123,077	116,545	94.7	47	117,238	95.3	48
1931	124,040	117,455	94.7	47	118,149	95.3	48
1932	124,840	118,904	95.2	48	118,904	95.2	48
1933	125,579	125,579	100.0	49	125,579	100.0	49

(1) Includes the District of Columbia.

Source: U.S. Bureau of the Census (1975), p. 44.

Table A-2. Dates of Entry to the Birth & Death Registration Areas. United States. 1900 to 1933.

State	Birth Registration Area	Death Registration Area	Notes
Alabama	1927	1925	
Arizona	1926	1926	
Arkansas	1927	1927	
California	1919	1906	
Colorado	1928	1906	
Connecticut	1915	1900	
Delaware	1921	1919	
Dist. Columbia	1915	1900	
Florida	1924	1919	
Georgia	1928	1922	(1)
Idaho	1926	1922	
Illinois	1922	1918	
Indiana	1917	1900	
Iowa	1924	1923	
Kansas	1917	1914	
Kentucky	1917	1911	
Louisiana	1927	1918	
Maine	1915	1900	
Maryland	1916	1906	
Massachusetts	1915	1900	
Michigan	1915	1900	
Minnesota	1915	1910	
Mississippi	1921	1919	
Missouri	1927	1911	
Montana	1922	1910	
Nebraska	1920	1920	
Nevada	1929	1929	
New Hampshire	1915	1900	
New Jersey	1921	1900	
New Mexico	1929	1929	
New York	1915	1900	
North Carolina	1917	1916	(2)
North Dakota	1924	1924	
Ohio	1917	1909	
Oklahoma	1928	1928	
Oregon	1919	1918	
Pennsylvania	1915	1906	
Rhode Island	1915	1900	(3)
South Carolina	1919	1916	(4)
South Dakota	1932	1930	(5)
Tennessee	1927	1917	
Texas	1933	1933	
Utah	1917	1910	
Vermont	1915	1900	
Virginia	1917	1913	
Washington	1917	1908	
West Virginia	1925	1925	
Wisconsin	1917	1908	
Wyoming	1922	1922	

(1) Georgia withdrew from the DRA for the years 1925-1927.
(2) North Carolina reported deaths in places of 1,000 & over for the years 1910-1915.
(3) Rhode Island withdrew from the BRA for the years 1919-1920.
(4) South Carolina withdrew from the BRA for the years 1925-1927.
(5) South Dakota was briefly in the DRA for the years 1906-1909.