Racial Health Inequities in the 19th Century US: Evidence from Childhood Sex Ratios

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Significance: Black-white health disparities in the US remain an important topic in both public and academic circles. Yet 19th-century disparities in infant mortality remain unknown, due to a lack of data. We use a novel indicator for infant mortality—childhood sex ratios—to give new evidence on racial disparities in infant mortality in the 19th-century US. Our method reveals enormous disparities in 19th-century infant mortality between the white and Black populations. The disparity is several times larger than the entire decline of white infant mortality from 1850 to today. In the case of the US, pre-industrial social structures (i.e. slavery) had a larger effect on infant mortality than the last 100 years of technological, medical, and economic progress.

Abstract: We introduce childhood sex ratios as a novel indicator of infant mortality and maternal-infant health. Because females have a biological survival advantage in infancy, high rates of infant death tend to skew the surviving population toward females. Using data from 19th-century Europe and settler societies, we document the relationship between infant mortality and under-5 sex ratios. We then apply this relationship to characterize infant mortality for the 19th-century US, where we have census data but not vital statistics. By our estimates, the Black-white infant mortality disparity in the 19th-century US was enormous: nearly 250 points (per 1000 births) . Circa 1850, US whites were among the healthiest of contemporary populations, with 3.3% more males than females in the under-5 population, suggesting infant mortality around 80 deaths per 1000. US Blacks were among the most unhealthy, with 2.2% more females than males in the under-5 population, suggesting infant mortality around 320 deaths per 1000.

Racial health disparities are of enduring importance in the US, both for researchers (David and Collins 2021) and the general public (Chatterjee and Davis 2017; Villarosa 2018). Today, a Black infant is twice as likely as a white infant to die before the age of one (Ely and Driscoll 2021). Infant mortality inequities would have been even more consequential in the past, when rates of infant death were commonly an order of magnitude larger than those seen today,[1] and infant death was a dreadful banality, rather than a rare event.

Unfortunately, the basic facts of infant mortality in the 19th-century US have yet to be determined, due to a lack of requisite evidence. The US was a relative latecomer in developing nationwide vital statistics, including records of births and deaths.[2] Researchers today simply lack the data necessary for estimating 19th-century infant mortality by standard demographic methods.[3] As put by Hacker (2010, 76): "Empirical research on infant and childhood mortality in the [19th-century] United States is sorely needed. Source material, however, remains a major issue."

Building on well-known biology and demography, we offer a new empirical basis for characterizing infant mortality in populations lacking vital statistics: childhood sex ratios. It has long been known that, biologically, females are less vulnerable than males to infant mortality.[4] The corollary which we highlight, and build from, is that high rates of infant mortality tend to skew childhood sex ratios toward girls, unless the female biological advantage is negated by gender discrimination. Leaving aside societies marred by the problem of "missing women" (Sen 1989), childhood sex ratios offer a basis for characterizing infant mortality when data for conventional demographic methods are unavailable.[5]

With low infant mortality, a healthy population of young children will have some 5-6% more males than females, reflecting a healthy sex ratio at birth (Maconochie and Roman 1997; Grech, Savona-Ventura, and Vassallo-Agius 2002). However, high rates of infant death tend to leave a surviving population distinctly more female than at birth. For example, in England circa 2000, infant mortality was around 5 per 1000 (Office of National Statistics data) and there were about 5% more boys than girls under the age of 5

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[1] In 19th-century Europe, infant mortality ranged from 100 deaths per 1000 to above 300. Today, US infant mortality is around 5 deaths per 1000 (Ely and Driscoll 2021).

[2] Vital statistics, records of births and deaths, were established across most of Europe by the mid 19th-century. In the US, nationwide vital statistics only arrived in 1933.

[3] Direct estimates of infant mortality require at least two of: births, infant deaths, and infant population. 'Indirect' estimates typically use maternal recall of child survival (UN Population Division 1983, chap. 3).

[4] Current knowledge is conveniently summarized by the editors of PLOS Medicine in their summary of Sawyer (2012): "Newborn girls survive better than newborn boys because they are less vulnerable to birth complications and infections and have fewer inherited abnormalities. Thus, the ratio of infant mortality among boys to infant mortality among girls is greater than one, provided both sexes have equal access to food and medical care." Knowledge of excess male infant mortality dates back at least to the 18th century, for example, Struyck (1740), Wargentin (1755), and Clarke (1786); for discussion, see Théré and Rohrbasser (2006). The female survival advantage in infancy is attributed to multiple factors: females have fewer congenital diseases owing to their redundant X chromosome, and they are also more resistant to infectious disease. For an authoritative review see Waldron (1998, 64–83).

[5] Our approach to characterizing infant mortality will be of limited value for societies with missing women, where the "social vulnerability" of young girls outweighs the "biological vulnerability" of infant males (Thompson 2021, 467). In such societies, extremes of gender discrimination offset the biological survival advantage of female infants (e.g. D'Souza and Chen 1980; Das Gupta 1987), and there will be no simple relationship between the level of infant mortality and childhood sex ratios.

(Office for National Statistics 2001, tbl. P3). In 1900, England's infant mortality was around 150 per 1000, and girls outnumbered boys (see data appendix).

The effect of infant mortality on the sex composition of the surviving population is well known in demography. Familiar model life tables, such as Coale-Demeny (1983), illustrate that as infant mortality falls, the surviving child population moves towards males.[6] Estimates of 'missing women' take into account the role of infant mortality on sex ratios (see Klasen 1994 in particular). More recent research has even used the expected relationship between infant mortality and childhood sex ratios in order to identify societies with 'missing women' (Beltrán Tapia and Raftakis 2021, figs. 2 & 3). However, the potential for childhood sex ratios to reveal infant mortality remains to be exploited .

The relationship between infant mortality and childhood sex ratios can be modeled concisely with life-table concepts. Let ${}_1q_0^i$ be the infant mortality rate of sex i, ${}_1l_1^i$ the population surviving to age one, and B^i births:[7]

$$(1)\quad log\left(\frac{{}_1l_1^f}{{}_1l_1^m}\right) \approx log\left(\frac{B^f}{B^m}\right) + \frac{{}_1q_0^m - {}_1q_0^f}{q_0} * q_0$$

The childhood sex ratio is determined by two additively separable terms: the sex ratio at birth ($log\left(\frac{B^f}{B^m}\right)$), and the relative survival of males and females ($\frac{{}_1q_0^m - {}_1q_0^f}{q_0} * q_0$). The effect of the level of infant mortality (q_0) on the sex ratio of survivors is determined by the degree of excess male mortality ($\frac{{}_1q_0^m - {}_1q_0^f}{q_0}$). This value is typically in the range of 15-30% (Hill and Upchurch 1995; Drevenstedt et al. 2008). The level of infant mortality thus interacts with the degree of excess male mortality to pull childhood sex ratios away from the sex ratio at birth. The greater the female survival advantage, the more infant mortality skews the sex ratio among survivors.

In historical populations, when infant mortality commonly ranged from under 100 to over 300 deaths per 1000, the effect of infant mortality of childhood sex composition was substantial. Starting from a healthy sex ratio at birth—say 5% more boys than girls—and with excess male mortality of 20% (typical of 19th-century Europe), infant mortality of 200 deaths per 1000 would drive the sex ratio of the surviving population to parity.

Of course, we would not expect a population with such high infant mortality to have a healthy sex ratio at birth, as a growing body of work demonstrates that insults to maternal well-being push the sex ratio at

[6] For example, in the Coale-Demeny West model, moving from level 11 to level 22 infant mortality plummets from 159 to 27 (per 1000) and the sex ratio among survivors to age five (5l0) shifts 2.14 percentage points away from girls (Coale and Demeny 1983, 47,52).

[7] See appendix for derivation; notation adapted from (Preston, Heuveline, and Guillot 2001). Observed sex ratios reflect an age interval (Lx) but we model populations at exact age (lx) for illustration of the general point. Moreover, because infant mortality is much greater and more male-skewed than later mortality (Hill and Upchurch 1995), the childhood sex ratio is mainly determined by infant mortality.

birth towards females (e.g., Almond and Edlund 2007; Fukuda et al. 1998; Catalano 2003).[8] Male frailty, in utero and in early infancy, means that poor maternal-infant health will be reflected both in terms of fewer males being born and fewer males surviving infancy. The direct effect of infant mortality on childhood sex ratios will, in most cases, be reinforced by a female-tilted sex ratio at birth, as infant mortality and maternal health are closely linked (e.g., Kramer 1987).[9]

Childhood sex ratio should thus reflect the infant mortality, and broader matrix of maternal-infant health within a population. The relationship between the sex ratio of surviving children and the level of infant mortality should be roughly linear. In a regression of childhood sex ratios on infant mortality, the intercept coefficient should reflect a healthy sex ratio at birth (5-6% male), and the slope coefficient the level of excess male mortality (15-30%).

In order to characterize the empirical relationship between childhood sex ratios and infant mortality, we assemble data from historical vital statistics.[10] Our data come from Europe, and the US and other settler societies, mostly from the mid-nineteenth century onward. We pair the under-5 sex ratio (children aged 0–4) with the rolling mean of infant mortality.[11] Each observation is a geographic unit in a particular census year.[12] We have 620 observations.

In Figure 1, we plot under-5 sex ratios against infant mortality. Their empirical correspondence is striking. Populations with low infant mortality have childhood sex ratios approaching 5% male, a typical sex ratio at birth in a healthy population. As we move to the right on the graph, infant mortality increases and childhood populations become more female, with parity occurring around 200 deaths per 1000. Populations with very high rates of infant mortality (250+) almost exclusively have more females than

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[8] The apparent mechanism is maternal stress hormones, which increase the probability of miscarriages, which are disproportionately male (James and Grech 2017, 51). The sex ratio at birth has been used as an indicator for maternal health and fetal loss (Davis, Gottlieb, and Stampnitzky 1998; Grech and Masukume 2016; Shifotoka and Fogarty 2013; Sanders and Stoecker 2015; Valente 2015; Guimbeau, Menon, and Musacchio 2020).

[9] Klasen (1994, 1064–66) noted this relationship between sex ratio at birth and infant mortality in the context of 'missing women'. A similar pattern can be seen today in the US between the white, Black, and indigenous populations. Black women have the highest rates of infant mortality, followed by indigenous, and then whites (Ely and Driscoll 2021); sex ratios of birth follow the same pattern, with Black women giving birth to the most females (Mathews and Hamilton 2005).

[10] When we refer to infant mortality 'data', we mean *direct estimates*. These are measures of infant mortality calculated from records of infant births and deaths. These are distinct from *indirect estimates* of infant mortality, which are typically derived from maternal recall of births and deaths using model life tables (see Hill 1991 for discussion). We treat these direct estimates as 'facts', and use them as 'training' or 'validation' data for characterizing an empirical relationship between infant mortality and childhood sex ratios.

[11] We use the under-5 sex ratio for several reasons: it is widely available in published census data, pooling the under-5 population increases the sample sizes (small samples are of concern for sex-ratios, see Visaria 1967 for discussion), and pooling across ages reduces the impact of sex-biased age heaping. We have one exception, Prussia from 1895 to 1910 (4 observations), where we use under-6 sex ratios, as the under-5 population is not available for our geographic units of interest.

[12] See the appendix below for the geographic and temporal scope of our data. Our data go no further than 1961; by then infant mortality in our sample populations was low enough that patterns of sex-ratio variation were largely independent of infant mortality, and ultrasound, which spread in the 1970s (Campbell 2013), was not yet a factor in sex-ratio patterns. Ultrasound and sex-selective abortion complicates the interpretation of childhood sex ratios.

males in the under-5 population. Infant mortality explains nearly three quarters of the variation in childhood sex ratios within our sample, with an R^2 of .72.

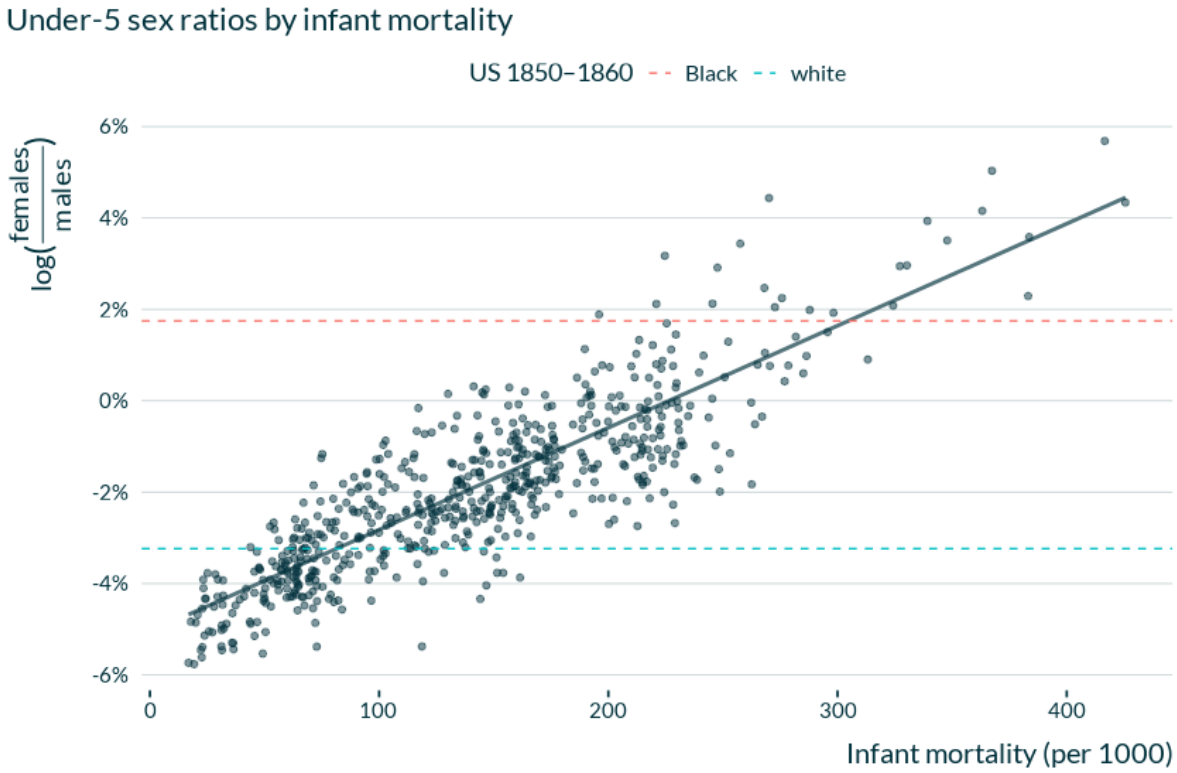

Figure 1: Under-5 Sex ratios by infant mortality, Europe and settler societies in the 19th and 20th centuries. Scatter plot and regression line, data from vital statistics and censuses, N=620. Dashed horizontal lines are US under-5 sex ratios by race, averaged across the 1850 and 1860 censuses; data from the full-count PUMS and published census volumes.

We use this observed relationship to infer broad patterns of infant mortality in the 19th-century US, where we lack vital statistics but have sex-ratio data from the census. Among many possible approaches, a simple regression of childhood sex ratios on infant mortality provides robust results. The least-squares fitted relationship is:[13]

$$\hat{SR} = -5.06 + .223 * q_0$$

This estimated relationship closely conforms to the theoretical relationship above. The regression intercept (-5.06%) corresponds to a healthy sex ratio at birth, with about 5% more boys than girls. The regression slope coefficient estimates the magnitude of the excess male mortality regression, and the 22.3% value falls well within the usual range for 19th-century European populations (Hill and Upchurch

[13] For clarity of exposition, we have scaled both infant mortality and sex ratios to be percentages (multiplied by 100).

1995; Drevenstedt et al. 2008). We use this estimated relationship to draw inferences on infant mortality given observed sex ratios. Our predicted infant mortality is given by:

$$\hat{IMR}_i = \frac{SR_i + 5.06}{.223}.$$

Results

Table 1: US under-5 female-to-male ratio (% terms) by race.

YEAR	Black	white	total	diff
1850	1.92	-3.47	-2.92	5.39
1860	2.34	-3.18	-2.70	5.51
1870	-0.46	-3.12	-2.74	2.66
1880	-0.42	-3.37	-2.90	2.95

Data from the decennial US census.

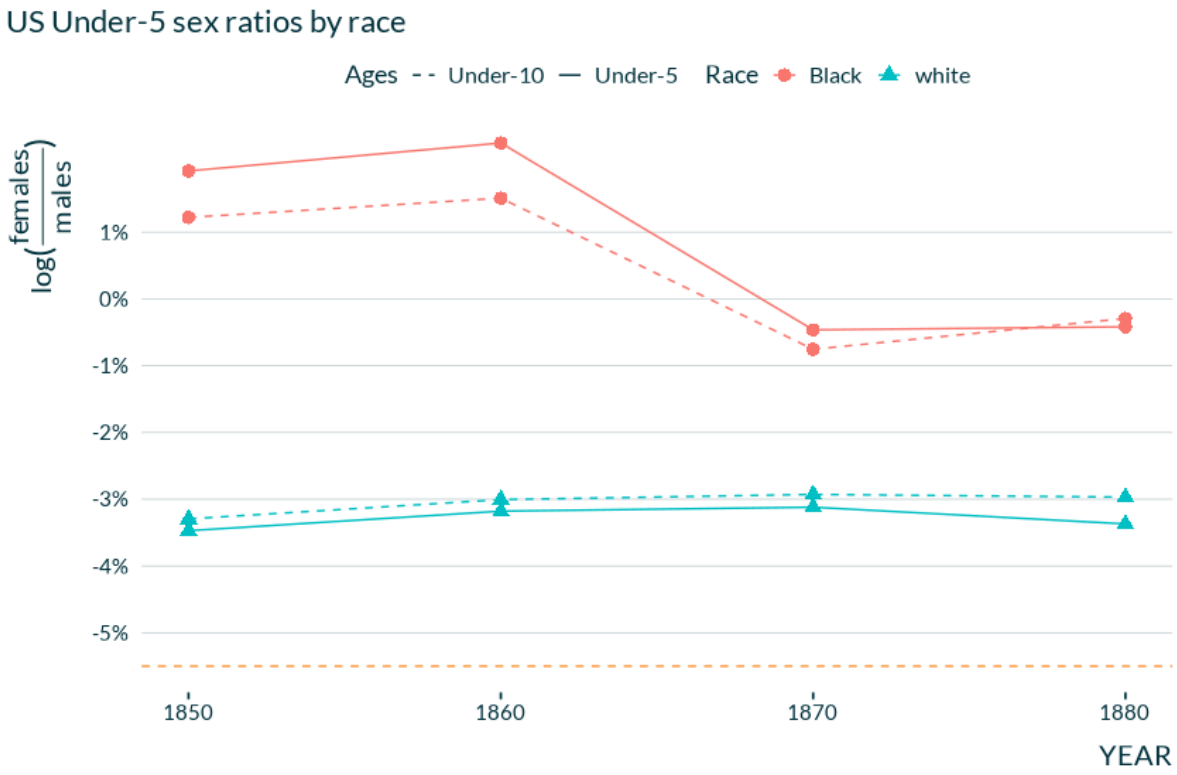

Figure 2: US female-to-male ratios (%-terms) by census benchmark year. Ages under-5 and under-10. Data from the decennial US census, both the full-count PUMS and published census volumes. The yellow dashed line is for reference, and represents a healthy sex ratio at birth (5.5% more males than females).

The US decennial census provides population by age and sex by race from 1850 onward. Taking the US as a whole, childhood sex ratios suggest that infant mortality was low in the US relative to contemporary Europe, albeit distinctly higher than it is today. With roughly 3% more males than females under the age of 5, the US at mid-century resembles the healthier contemporary European populations, such as Scotland or Norway. The US sex ratios suggest infant mortality around 100 deaths per 1000.

However, much like today, the US aggregate obscures a profound racial disparity. US whites had roughly 3.3% more males than females in the 1850 and 1860 under-5 populations, slightly more male-skewed than the healthiest of European populations. These sex ratios suggest infant mortality around 80 deaths per 1000. US Blacks, on the other hand, had 2.2% more females than males under the age of 5 in both 1850 and 1860. Such female-skewed populations are rare in Figure 1, placing US Blacks among the most unhealthy of contemporary populations. US Black infant mortality was likely around 320 deaths per 1000.

In both 1850 and 1860, there was a striking racial disparity in childhood sex ratios, with whites some 5.5% more male than Blacks.[14] Based on the regression above, the disparity in sex ratios translates into a nearly 250 point difference in infant mortality rates between the Black and white populations, and it indicates that the Black infant mortality was some 3-4 times that of whites.[15]

In our view, the striking racial disparity in childhood sex ratios was a symptom of slavery, and a reflection of dreadfully high rates of infant mortality for the enslaved population. After emancipation, the racial gap in childhood sex ratios fell in half (comparing 1870-1880 to 1850-1860). White sex ratios were roughly constant across the period, at around 3.3% male (see Figure 2). Black sex ratios moved some 2.8 points toward males, from 2.2% female to 0.5% male. This change is powerful evidence of a substantial improvement in Black infant mortality, and of maternal and infant health more generally. Extrapolating from the relationship estimated for Figure 1, emancipation narrowed the racial infant mortality gap from nearly 250 points to about 125 points, as Black infant mortality fell from around 320 to just over 200. However, despite this improvement, Black infant mortality circa 1870-1880 was still more than twice that of white – a relative gap that has persisted to today, even as infant mortality rates collapsed over the course of the 20th century.

We offer the substantial racial differences in under-5 sex ratios of the mid-19th-century US as powerful evidence of an enormous racial disparity in infant mortality (and maternal-infant health more generally). The same pattern of racial differences is found in the sex ratios of the under-10 populations of 1850 to 1880. Looking at Figure 2, there is a remarkably close correspondence between the under-5 and under-10 sex ratios; this correspondence serves to stave off a potential concern that sex-biased age-heaping might be responsible for our results.

[14] The racial disparity in childhood sex ratios is even larger if we restrict attention to the South, suggesting little role for geography.

[15] For clarity of presentation, we highlight the implications of the regression equation; but our results are robust to alternative specifications, as you would expect from the very strong empirical relationship seen in Figure 1.

Another potential robustness issue is the under-enumeration of infants and younger children, a concern often raised in the context of historical US censuses (Coale and Zelnik 1963; Hacker 2013). We address this problem by following cohorts across multiple censuses. In Table 2, we compare young adult (age 9-27) sex ratios in 1870 and 1900 by race.[16] There we see much the same patterns as in contemporary childhood sex ratios: the Black cohort born under slavery (age 9-27 in 1870) were much more female-skewed than the corresponding white population; and the Black population born after emancipation (age 9-27 in 1900) were less female-skewed than those born under slavery.[17]

Table 2: US female-to-male ratios (%-terms) for ages 9-27.

Year	Black	white
1870	7.67	1.74
1900	4.67	-0.60

Data from the 1870 and 1900 US Census full-count PUMS.

Discussion

Childhood sex ratios paint a stark picture of the 19th-century US. The US as a whole had relatively low infant mortality compared to contemporary Europe, hardly surprising in light of the swelling tides of trans-atlantic immigration as the 19th century advanced. However, the US aggregate obscures an enormous racial difference. While the free US whites were among the healthiest of contemporary populations, enslaved US Blacks suffered some of the highest rates of infant mortality observed during the period. Black infant mortality under slavery was roughly 4 times that of whites, with an absolute gap upwards of 200 deaths per 1000. By our estimates, nearly 1-in-3 Black infants died in their first year of life, compared to fewer than 1-in-10 white infants.

The sex-ratio evidence reveals a racial disparity in infant mortality that is much larger than has been suggested in most previous discussion of the issue. At one extreme, in their controversial account of the economics of US slavery, Fogel and Engerman (1974, 1:124) claim that infant mortality for Blacks under slavery was “virtually the same”" as for the southern white population. In contrast, indirect estimates of infant mortality point towards a clear racial disparity under slavery (Farley 1965; Eblen 1974). The largest previous estimates of the racial disparity in infant mortality under slavery can be found in the most recent edition of the *Historical Statistics of the United States* (2006). Drawing on Haines (1979) for the white population and Steckel (1986) for the Black, HSUS puts white infant mortality circa 1850 at 217 deaths

[16] We use 1900 because the 1890 Census records were lost in a fire, so there is no PUMS data available. Also, age reporting in the 1890 census was not consistent with practices in the other censuses. As discussed in 1900 and 1910 census reports, only the 1890 census asked for “age at nearest birthday” instead of “age at last birthday”, which was used from 1850 to 1880, and from 1900 forward (page xlviii of Twelfth Census (1900), Census Reports Volume II, Population Part II, Washington: GPO, 1902). Therefore we exclude 1890 from our analysis.
[17] The same basic pattern is observed with other relevant age-groupings.

per 1000 (2006, Ab921) and 340 for the Black population (2006, Ab923).[18] All of these agree on the basic characterization of generally high infant mortality in the 19th-century US, albeit worse for Blacks than whites.

Childhood sex ratios suggest, in contrast, that the 19th-century US was a low-mortality place by contemporary standards, with the experience of the Black population an glaring exception. The female-skewed childhood sex ratios of the enslaved population corroborate the most pessimistic views of Black population health under slavery. However, the relatively male-skewed sex ratios of the free white population suggest that white infant mortality was much lower than currently held. Our downward revision fits into a broader range of historical evidence of the 19th-century US as a healthy place by contemporary standards (McDevitt-Irwin and Irwin 2022).[19]

Our corroboration of high infant mortality among the Black population, together with the finding that white infant mortality was relatively low, implies a much larger racial disparity in infant mortality under slavery than previously thought. US whites and Blacks were part of the same society, yet they stood at the two extremes of recorded 19th-century mortality experiences. By our estimates, US whites had lower infant mortality than the healthiest of European polities. Under slavery Blacks had among the highest rates of infant mortality observed in the 19th century.

The mid-19th-century US racial disparity dwarfs cross-country differences in infant mortality rates observed today. The lowest recorded infant mortality rate in 2020 was Slovenia, with 1.7 deaths per 1000 births. The country with the highest was Afghanistan, at 105 (CIA Factbook). Circa 1850, the Black-white difference in infant mortality was roughly twice the largest such disparity in the world today.

After emancipation, Black infant mortality improved substantially, pointing to the institution of slavery as responsible for the uniquely large health disparity described above. Between 1860 and 1870 Black childhood sex ratios moved 2.8 percentage points towards males, suggesting a decrease in infant mortality of over 100 deaths per 1000. This improvement contrasts with previous views, which argued that Black health remained the same—or even deteriorated—after emancipation (Farley 1965; Fogel and Engerman 1974, 1:261; Eblen 1974; Meeker 1976). Left to their own devices, Black families were able to achieve much lower infant mortality after emancipation than they had experienced under slavery.[20]

Maternal stress likely played a major role in determining Black reproductive health under slavery. Recent scholarship in social history points towards experiences of extreme stress for the enslaved, especially women (e.g., Hartman 1997), under the threat of sexual violence (Jones 2003). Medical research has demonstrated the important role of stress on maternal-infant health (Oths, Dunn, and Palmer 2001; Loomans et al. 2013), particularly for the Black population (Collins and David 2009). High levels of

[18] Although presented in the HSUS, we suggest these IMR 'estimates' are best thought of as conjectures, as they have no basis in data on births or infant deaths in the populations of interest (McDevitt-Irwin and Irwin 2022).
[19] Among key considerations: US whites were among the tallest populations of the 19th century (Fogel et al. 1983). In addition, the US was predominantly rural during the nineteenth century, a period when there was a substantial "urban penalty" (Condran and Crimmins 1980; Kearns 1988) in mortality. Moreover, the US drew tens of millions of voluntary immigrants from Europe over the period, presumably drawn by better living standards.
[20] The improvement in Black health with emancipation is particularly striking in light of the large decline in per-capita income witnessed in the US South over the same period (Easterlin 1961).

chronic stress among mothers would have contributed to high rates of fetal loss (Qu et al. 2017) and infant mortality (e.g., through preterm birth, Shaikh et al. 2013). The body of recent research focusing on stress as a determinant of health, suggests that the lived experience and trauma of enslaved women was more than enough to explain enormous racial disparity in maternal-infant health under slavery.[21]

Very few general facts have been established for the 19th-century Black population, largely due to a lack of comprehensive evidence. One fact dominates the research landscape: that the enslaved Black population grew at a similar rate as the native-born white population (Engerman 1976).[22] As Fogel (1989, 1:119) discusses, the natural increase of US Blacks was interpreted by contemporaries, and by scholars later, as evidence of benign material living conditions of US Blacks under slavery. More narrowly, Fogel and Engerman argue that the profit motive of plantation owners was enough to ensure "adequate maintenance of the health" of the enslaved population (1974, 1:123–26). In this view, the poor health of US Blacks under slavery was due to "the primitive nature of medical knowledge and practices in the antebellum era," rather than the actual social structure of slavery (ibid).[23]

Our results baldly contradict this view of US slavery. US Blacks and whites may have shared a similar rate of natural increase, but this came from starkly different patterns of mortality and fertility. US Blacks and whites resemble populations on opposite sides of demographic transition: one experiencing an extremely 'high-pressure demographic regime' while the other a relatively 'low-pressure' one. This difference was in no way inevitable; it was due to the extreme social inequalities of slavery.

Our results focus attention on the role of social structures in determining population health. Structural racism is widely acknowledged as a driver of today's racial health disparities (Bailey et al. 2017). The antebellum US offers an even more extreme example of social structure driving mortality. Slavery in the US was responsible for a staggering number of infant deaths, with Black mothers losing infants at 3-4 times the rate of the free white population. Even after emancipation, Black infant mortality remained about twice that of whites. We can only speculate what difference there might have been had the full promise of reconstruction—'40 acres and a mule'—been fulfilled;[24] but we are confident that Black infant mortality would have been much lower (much closer to that of contemporary rural whites).

The US of the 1850s was a place of extremes. US whites had some of the lowest infant mortality rates in the world. US Blacks had some of the highest. Enormous progress would be seen over the following 150

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[21] Of course other features of slavery likely contributed to high infant mortality, such as physical violence (Hartman 1997), overwork (Campbell 1984), and malnutrition (Steckel 1986).

[22] This rate of natural increase makes slavery in the US unique in the Americas, as other enslaved populations were population sinks (Klein and Engerman 1978).

[23] See Postell (Postell 1952, 538) for a similar view, writing in *Pediatrics* that the medical care provided to enslaved mothers was "still far superior to anything the Negro had known in Africa, and compared favorably with the medical knowledge of the antebellum period." Such views, evoking slavery apologists, are no longer tenable. See Schwartz (2010) for an example of recent scholarship on reproductive health under slavery, and Owens and Fett (2019) for discussion of the troubling relationship of medicine and public health to slavery and race in US history.

[24] The US government had suggested breaking up large plantations for Black freedmen to take as property, but never enacted this policy. See Fleming (1906) and Du Bois (1910; 1935) for early academic discussion of 'forty acres and mule'. More recently, Darity (2008, 661) speculates that "had the promise of 40 acres been fulfilled, one can readily imagine a completely different U.S. history unfolding over the course of the subsequent century, a history in which race did not intertwine with dense inequalities."

years, with infant mortality plummeting for all groups in the US. However, the 20th-century decline in US infant mortality was smaller (in absolute terms) than the difference between Blacks and whites in 1850. In terms of infant mortality, US whites in 1850 were closer to today's populations than to contemporary Blacks. The decline in Black infant mortality after emancipation was larger than the decline in white infant mortality from 1850 to today. Placed in a historical perspective, the institution of slavery had a larger effect on life and death than did the following century of social and economic progress.

Appendices

Derivation of equation (1)

By definition, the number of survivors of each sex is equal to the number of births times the survival rate (1 minus the mortality rate):

$$log(\frac{l^f{}_1}{l^m{}_1}) = log(\frac{B^f * (1-q^f{}_0)}{B^m * (1-q^m{}_0)}) = log(\frac{B^f}{B^m}) + log(1 - q^f{}_0) - log(1 - q^m{}_0)$$

Taking a first-order Taylor approximation ($log(1 + x) \approx x$), and defining q_0 as overall infant mortality, we obtain:

$$log(\frac{l^f{}_1}{l^m{}_1}) \approx log(\frac{B^f}{B^m}) - q^f{}_0 + q^m{}_0 \approx log(\frac{B^f}{B^m}) + \frac{q^m{}_0 - q^f{}_0}{q_0} * q_0 \ .$$

Data

The data for Figure 1 and regression analysis are direct estimates of infant mortality, taken from vital statistics, combined with under-5 sex ratios from censuses and population registries. Our non-US data cover: Sweden (1753–1960), Denmark (1836–1960), Belgium (1840–1960), England and Wales (1847–1961), the Netherlands (1855–1960), Scotland (1857–1960), New Zealand (1863–1961), Austria (1865–1961), Australia (1876–1961), Germany (1849–1961), Switzerland (1876–1960), Finland (1881–1960), Norway (1886–1960), France (1897–1954), Italy (1907–1961), and South Africa (1914–1921). Our US data cover Massachusetts from 1856–1960, and an increasing number of states from 1900 onward.

The data for Figure 2 and Tables 1 and 2 come from the decennial US census. When possible, we use both the population counts from published census volumes and the full-count Public Use Microdata Sample (PUMS).

For fuller description and sources, see the online data appendix (link).

References

Almond, Douglas, and Lena Edlund. 2007. “Trivers-Willard at Birth and One Year: Evidence from US Natality Data 1983--2001.” *Proceedings of the Royal Society B: Biological Sciences* 274 (1624): 2491–96.

Bailey, Zinzi D., Nancy Krieger, Madina Agénor, Jasmine Graves, Natalia Linos, and Mary T. Bassett. 2017. “Structural Racism and Health Inequities in the USA: Evidence and Interventions.” *The Lancet* 389 (10077): 1453–63.

Beltrán Tapia, Francisco J., and Michail Raftakis. 2021. “Sex Ratios and Gender Discrimination in Modern Greece.” *Population Studies*, 1–18.

Campbell, S. 2013. “A Short History of Sonography in Obstetrics and Gynaecology.” *Facts, Views & Vision in ObGyn* 5 (3): 213–29.

Carter, Susan B., Scott Sigmund Gartner, Michael R. Haines, Alan L. Olmstead, Richard Sutch, and Gavin Wright, eds. 2006. *Historical Statistics of the United States*. Millennium edition. Cambridge University Press.

Catalano, Ralph A. 2003. “Sex Ratios in the Two Germanies: A Test of the Economic Stress Hypothesis.” *Human Reproduction* 18 (9): 1972–75.

Chatterjee, Rhitu, and Rebecca Davis. 2017. “How Racism May Cause Black Mothers To Suffer The Death Of Their Infants.” *NPR*, December 20, 2017, sec. You, Me And Them: Experiencing Discrimination In America. https://www.npr.org/sections/health-shots/2017/12/20/570777510/how-racism-may-cause-black-mothers-to-suffer-the-death-of-their-infants.

Clarke, Joseph. 1786. “Observations on Some Causes of the Excess of the Mortality of Males above That of Females.” *The London Medical Journal* 9 (Pt 2): 179.

Coale, Ansley J., and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations*. 2nd ed. Studies in Population. Academic Press.

Coale, Ansley J., and Melvin Zelnik. 1963. *New Estimates of Fertility and Population in the United States*. Princeton University Press.

Collins, James W., and Richard J. David. 2009. “Racial Disparity in Low Birth Weight and Infant Mortality.” *Clinics in Perinatology*, Current Controversies in Perinatology, 36 (1): 63–73. https://doi.org/10.1016/j.clp.2008.09.004.

Condran, Gretchen A., and Eileen Crimmins. 1980. “Mortality Differentials between Rural and Urban Areas of States in the Northeastern United States 1890–1900.” *Journal of Historical Geography* 6 (2): 179–202.

Darity Jr, William. 2008. “Forty Acres and a Mule in the 21st Century.” *Social Science Quarterly* 89 (3): 656–64.

Das Gupta, Monica. 1987. “Selective Discrimination against Female Children in Rural Punjab, India.” *Population and Development Review*, 77–100.

David, Richard, and James W. Collins. 2021. “Why Does Racial Inequity in Health Persist?” *Journal of Perinatology* 41 (2): 346–50.

Davis, Devra Lee, Michelle B. Gottlieb, and Julie R. Stampnitzky. 1998. “Reduced Ratio of Male to Female Births in Several Industrial Countries: A Sentinel Health Indicator?” *Jama* 279 (13): 1018–23.

Drevenstedt, Greg L., Eileen M. Crimmins, Sarinnapha Vasunilashorn, and Caleb E. Finch. 2008. “The Rise and Fall of Excess Male Infant Mortality.” *Proceedings of the National Academy of Sciences* 105 (13): 5016–21.

D’Souza, Stan, and Lincoln C. Chen. 1980. “Sex Differentials in Mortality in Rural Bangladesh.” *Population and Development Review*, 257–70.

Du Bois, WE Burghardt. 1910. “Reconstruction and Its Benefits.” *The American Historical Review*, 781–99.

———. 1935. *Black Reconstruction in America: An Essay Toward a History of the Part Which Black*

Folk Played in the Attempt to Reconstruct Democracy in America, 1860–1880. New York: Harcourt, Brace and Company.

Eblen, Jack Ericson. 1974. "New Estimates of the Vital Rates of the United States Black Population during the Nineteenth Century." *Demography* 11: 301–19.

Ely, Danielle M., and Anne K. Driscoll. 2021. "Infant Mortality in the United States, 2019: Data from the Period Linked Birth/Infant Death File." *National Vital Statistics Reports: From the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System* 70 (14): 1–18.

Engerman, Stanley L. 1976. "Some Economic and Demographic Comparisons of Slavery in the United States and the British West Indies'." *The Economic History Review* 29 (2): 258–75.

Farley, Reynolds. 1965. "The Demographic Rates and Social Institutions of the Nineteenth-Century Negro Population: A Stable Population Analysis." *Demography* 2 (1): 386–98.

Fleming, Walter L. 1906. "Forty Acres and a Mule." *The North American Review* 182 (594): 721–37.

Fogel, Robert W., and Stanley L. Engerman. 1974. *Time on the Cross: The Economics of American Negro Slavery*. Vol. 1. Little Brown and Company.

Fogel, Robert W., Stanley L. Engerman, Roderick Floud, Gerald Friedman, Robert A. Margo, Kenneth Sokoloff, Richard H. Steckel, T. James Trussell, Georgia Villaflor, and Kenneth W. Wachter. 1983. "Secular Changes in American and British Stature and Nutrition." *Journal of Interdisciplinary History* 14 (2): 445. https://doi.org/10.2307/203716.

Fogel, Robert William. 1989. *The Rise and Fall of American Slavery: Without Consent or Contract*. Vol. 1. New York: WW Norton & Company.

Fukuda, Misao, Kyomi Fukuda, Takashi Shimizu, and Henrik Møller. 1998. "Decline in Sex Ratio at Birth after Kobe Earthquake." *Human Reproduction (Oxford, England)* 13 (8): 2321–22.

Grech, Victor, and Gwinyai Masukume. 2016. "The Sex Ratio at Birth in South Africa May Be a Sentinel Health Indicator." *Early Human Development* 103 (December): 225–27.

Grech, Victor, Charles Savona-Ventura, and P. Vassallo-Agius. 2002. "Unexplained Differences in Sex Ratios at Birth in Europe and North America." *BMJ: British Medical Journal* 324 (7344): 1010–11.

Guimbeau, Amanda, Nidhiya Menon, and Aldo Musacchio. 2020. "The Brazilian Bombshell? The Long-Term Impact of the 1918 Influenza Pandemic the South American Way." No. w26929. National Bureau of Economic Research.

Hacker, J. David. 2010. "Decennial Life Tables for the White Population of the United States, 1790–1900." *Historical Methods* 43 (2): 45–79.

———. 2013. "New Estimates of Census Coverage in the United States, 1850-1930." *Social Science History; Durham* 37 (1): 71–101. http://dx.doi.org.cmich.idm.oclc.org/10.1017/S0145553200010579.

Haines, Michael R. 1979. "The Use of Model Life Tables to Estimate Mortality for the United States in the Late Nineteenth Century." *Demography* 16 (2): 289–312.

Hartman, Saidiya. 1997. *Scenes of Subjection: Terror, Slavery, and Self-Making in Nineteenth-Century America*. Race and American Culture. Oxford, New York: Oxford University Press.

Hill, Kenneth. 1991. "Approaches to the Measurement of Childhood Mortality: A Comparative Review." *Population Index* 57 (3): 368–82.

Hill, Kenneth, and Dawn M. Upchurch. 1995. "Gender Differences in Child Health: Evidence from the Demographic and Health Surveys." *Population and Development Review*, 127–51.

James, William H., and Victor Grech. 2017. "A Review of the Established and Suspected Causes of Variations in Human Sex Ratio at Birth." *Early Human Development* 109: 50–56.

Jones, Norrece T. 2003. "Rape in Black and White: Sexual Violence in the Testimony of Enslaved and Free Americans." In *Slavery and the American South*, edited by Annette Gordon-Reed, Peter S. Onuf, James Oakes, Walter Johnson, Ariela Gross, Laura F. Edwards, Jan Lewis, et al., 93–116. University Press of Mississippi. https://www.jstor.org/stable/j.ctt2tvfbq.

Kearns, Gerry. 1988. "The Urban Penalty and the Population History of England." In *Society, Health and*

Population during the Demographic Transition, 213–36. Umeå Universitet.; Demografiska Databasen No. 4. Stockholm: Almqvist & Wiksell.
Klasen, Stephan. 1994. "'Missing Women' Reconsidered." *World Development* 22 (7): 1061–71.
Klein, Herbert S., and Stanley L. Engerman. 1978. "Fertility Differentials between Slaves in the United States and the British West Indies: A Note on Lactation Practices and Their Possible Implications." *The William and Mary Quarterly: A Magazine of Early American History*, 357–74.
Kramer, M. S. 1987. "Determinants of Low Birth Weight: Methodological Assessment and Meta-Analysis." *Bulletin of the World Health Organization* 65 (5): 663–737.
Loomans, Eva M., Aimée E. Van Dijk, Tanja GM Vrijkotte, Manon Van Eijsden, Karien Stronks, Reinoud JBJ Gemke, and Bea RH Van Den Bergh. 2013. "Psychosocial Stress during Pregnancy Is Related to Adverse Birth Outcomes: Results from a Large Multi-Ethnic Community-Based Birth Cohort." *The European Journal of Public Health* 23 (3): 485–91.
Maconochie, Noreen, and Eve Roman. 1997. "Sex Ratios: Are There Natural Variations within the Human Population?" *BJOG: An International Journal of Obstetrics & Gynaecology* 104 (9): 1050–53.
Mathews, T. J., and Brady E. Hamilton. 2005. "Trend Analysis of the Sex Ratio at Birth in the United States." *National Vital Statistics Reports* 53 (20): 1–17.
McDevitt-Irwin, Jesse, and James R. Irwin. 2022. "US Infant Mortality in the 19th Century: New Evidence from Childhood Sex Ratios." Unpublished manuscript. https://jrmcirwin.github.io/sr1/USimr.pdf.
Meeker, Edward. 1976. "Mortality Trends of Southern Blacks, 1850–1910: Some Preliminary Findings." *Explorations in Economic History* 13 (1): 13–42.
Office for National Statistics. 2001. *Census 2001: First Results on Population for England and Wales*. London: HMSO.
Oths, Kathryn S., Linda L. Dunn, and Nancy S. Palmer. 2001. "A Prospective Study of Psychosocial Job Strain and Birth Outcomes." *Epidemiology*, 744–46.
Owens, Deirdre Cooper, and Sharla M. Fett. 2019. "Black Maternal and Infant Health: Historical Legacies of Slavery." *American Journal of Public Health* 109 (10): 1342–45.
Postell, William Dosite. 1952. "Birth and Mortality Rates among Slave Infants on Southern Plantations." *Pediatrics* 10 (5): 538–42.
Preston, Samuel H., Patrick Heuveline, and Michel Guillot. 2001. *Demography: Measuring and Modeling Population Processes*. Oxford: Blackwell Publishing.
Qu, Fan, Yan Wu, Yu-Hang Zhu, John Barry, Tao Ding, Gianluca Baio, Ruth Muscat, Brenda K. Todd, Fang-Fang Wang, and Paul J. Hardiman. 2017. "The Association between Psychological Stress and Miscarriage: A Systematic Review and Meta-Analysis." *Scientific Reports* 7 (1): 1–8.
Sanders, Nicholas J., and Charles Stoecker. 2015. "Where Have All the Young Men Gone? Using Sex Ratios to Measure Fetal Death Rates." *Journal of Health Economics* 41 (May): 30–45.
Sawyer, Cheryl Chriss. 2012. "Child Mortality Estimation: Estimating Sex Differences in Childhood Mortality since the 1970s." *PLOS Medicine* 9 (8): e1001287.
Schwartz, Marie Jenkins. 2010. *Birthing a Slave: Motherhood and Medicine in the Antebellum South*. Cambridge, MA: Harvard University Press.
Sen, Amartya. 1989. "Women's Survival as a Development Problem." *Bulletin of the American Academy of Arts and Sciences* 43 (2): 14–29. https://doi.org/10.2307/3824748.
Shaikh, Kiran, Shahirose Premji, Khurshid Khowaja, Suzanne Tough, Ambreen Kazi, and Shaneela Khowaj. 2013. "The Relationship between Prenatal Stress, Depression, Cortisol and Preterm Birth: A Review." *Open Journal of Depression* 2 (3): 24.
Shifotoka, Anna, and Andrew W. Fogarty. 2013. "Is the Human Sex Ratio at Birth a Sentinel Health Indicator That Is Associated with HIV/AIDS and Tuberculosis Prevalences in the 21st Century?" *J Epidemiol Community Health* 67 (4): 327–31.
Steckel, Richard H. 1986. "Birth Weights and Infant Mortality among American Slaves." *Explorations in Economic History* 23 (2): 173–98.

Struyck, Nicolaas. 1740. *Inleiding Tot de Algemeene Geographie, Benevens Eenige Sterrekundige En Andere Verhandelingen*. Amsterdam: Issak Tirion.

Théré, Christine, and Jean-Marc Rohrbasser. 2006. "Facing Death in the Early Days of Life: Inequality between the Sexes in Enlightenment Demographic Thought." *The History of the Family* 11 (4): 199–210.

Thompson, Amanda L. 2021. "Greater Male Vulnerability to Stunting? Evaluating Sex Differences in Growth, Pathways and Biocultural Mechanisms." *Annals of Human Biology* 48 (6): 466–73.

UN Population Division. 1983. *Manual X: Indirect Techniques for Demographic Estimation*. New York: United Nations, Department of Economic and Social Affairs. https://unstats.un.org/unsd/demographic/standmeth/handbooks/Manual%20X.pdf.

Valente, Christine. 2015. "Civil Conflict, Gender-Specific Fetal Loss, and Selection: A New Test of the Trivers-Willard Hypothesis." *Journal of Health Economics* 39: 31–50.

Villarosa, Linda. 2018. "Why America's Black Mothers and Babies Are in a Life-or-Death Crisis." *The New York Times*, April 11, 2018, sec. Magazine. https://www.nytimes.com/2018/04/11/magazine/black-mothers-babies-death-maternal-mortality.html.

Visaria, Pravin M. 1967. "Sex Ratio at Birth in Territories with a Relatively Complete Registration." *Eugenics Quarterly* 14 (2): 132–42.

Waldron, Ingrid. 1998. "Sex Differences in Infant and Early Childhood Mortality: Major Causes of Death and Possible Biological Causes." In *Too Young to Die: Genes or Gender?*, edited by Alan D. Lopez and Lado T. Ruzicka, 64–83. 155. New York: United Nations.

Wargentin, Pehr. 1755. "Anmärkningar Om Nyttan Af Årliga Förtekningar På Födda Och Döda i et Land." *Sjette Stycket. Kongl. Vetenskaps Academiens Handlingar För År 1755* 16: 241–53.