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Jim Crow and Premature Mortality Among the US Black and White Population, 1960–2009:

An Age–Period–Cohort Analysis

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Abstract

Background—Scant research has analyzed the health impact of abolition of Jim Crow (ie, legal racial discrimination overturned by the US 1964 Civil Rights Act).

Methods—We used hierarchical age–period–cohort models to analyze US national black and white premature mortality rates (death before 65 years of age) in 1960–2009.

Results—Within a context of declining US black and white premature mortality rates and a persistent 2-fold excess black risk of premature mortality in both the Jim Crow and non-Jim Crow states, analyses including random period, cohort, state, and county effects and fixed county income effects found that, within the black population, the largest Jim Crow-by-period interaction occurred in 1960–1964 (mortality rate ratio [MRR] = 1.15 [95% confidence interval = 1.09–1.22), yielding the largest overall period-specific Jim Crow effect MRR of 1.27, with no such interactions subsequently observed. Furthermore, the most elevated Jim Crow-by-cohort effects occurred for birth cohorts from 1901 through 1945 (MRR range = 1.05–1.11), translating to the largest overall cohort-specific Jim Crow effect MRRs for the 1921–1945 birth cohorts (MRR ~ 1.2), with no such interactions subsequently observed. No such interactions between Jim Crow and either period or cohort occurred among the white population.

Conclusion—Together, the study results offer compelling evidence of the enduring impact of both Jim Crow and its abolition on premature mortality among the US black population, although insufficient to eliminate the persistent 2-fold black excess risk evident in both the Jim Crow and non-Jim Crow states from 1960 to 2009.

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Despite the widely recognized importance of analyzing trends in population health in relation to age, period, and cohort effects, such analyses have been hampered by 2 issues: the well-known "identifiability" problem (whereby age = period–cohort, rendering it impossible to include all 3 variables as covariates in the same model) and, less well-appreciated, computational difficulties in testing for effect modification by covariates in the classic age–period–cohort accounting model.[1] Recently developed hierarchical age–period–cohort methods potentially address both problems. These methods draw on generalized linear mixed-model approaches to enable the identification of independent age, period, and cohort effects, assuming valid a priori theoretical assumptions about the data-generating process.[2–7] Particularly relevant to the analysis of health inequities, these hierarchical models readily enable testing whether age–period–cohort effects vary across specified groups, via their ability to model, at multiple levels, not only random and fixed effects but also interaction effects.

Yet, despite growing application of hierarchical age–period–cohort methods in epidemiologic research,[2–6] few studies have investigated age–period–cohort effects and social inequalities in health. Among these studies are 2 concerning US race/ethnicity and gender, of which one focused on diverse self-reported health outcomes[7] and the other on cancer incidence and mortality.[6] The other 3 addressed socioeconomic position and US mortality,[8] self-rated health in China,[9] and smoking in Germany.[10] Notably, all 5 studies focused only on observed differences in age–period–cohort effects by sociodemographic categories; none included data on societal phenomena that might be contributing to the observed sociodemographic variation in age–period–cohort effects.

We accordingly extended the use of hierarchical age–period–cohort models to a scenario in which a major change in social policy could be expected to produce important period and cohort health effects. Guided by the ecosocial theory of disease distribution and its emphasis on how people embody their societal and ecological context, within and across generations,[11] the case example we selected is abolition of Jim Crow in the United States, ie, state laws legalizing racial discrimination overturned by the 1964 US Civil Rights Act.[12–14] Jim Crow, a form of structural legal racial discrimination established by US state and local governments in the 1870s and 1880s to bolster white supremacy, was directed chiefly against black Americans and also encompassed other racial/ethnic groups legally defined as "not white" (eg, American Indians and Asian Americans).[12,13] States with Jim Crow laws imposed legal restrictions for black and other "non-white" persons and created legal privileges for white persons in education, transportation, hospital and penal institutions, welfare institutions, employment, marriage, public accommodation, other public venues, and voting.[12,13] Attesting to the myriad laws enacted is the pathbreaking text *States' Laws on Race and Color*,[12] which was the first comprehensive compilation of state and local ordinances. Published in 1950 by Pauli Murray, this volume contains 524 pages (not counting appendices) enumerating these restrictions. Adversely affecting all major pathways by which racism is hypothesized to become embodied and harm health—including economic and social deprivation, social trauma, inadequate medical care, excess exposure to toxins, pathogens, and hazards, and people's responses to discrimination—the enforcement

(and subsequent abolition) of Jim Crow can plausibly be predicted to be major determinants of population health, especially for the social groups subjected to racial discrimination.[11,14]

Underscoring the contemporary, not just historical, relevance of this example, all US-born persons 49 years of age and older in 2013 were born when Jim Crow was legal in 21 of the 50 states plus the District of Columbia, alongside the de facto discrimination in the remaining 29 states.[14] Supporting our use of this example, 5 empirical population-based health investigations have focused on the abolition of Jim Crow, all providing suggestive evidence of a beneficial impact on black health (especially for infant mortality) and also a reduction in some black versus white health inequities.[15–19] Among these studies, only one used a hierarchical modeling approach to incorporate both state- and county-level variation, which notably changed the magnitude of the observed Jim Crow effect over time.[19] Building on this hierarchical modeling approach, the present study uses hierarchical age–period–cohort models to address Jim Crow effects more fully, by focusing on the US rates of premature mortality (death before 65 years of age), selected because it is, like infant mortality, a key indicator of population health and also one that avoids well-known problems of misclassification of—and changes in coding of—cause-specific mortality.[20,21]

METHODS

Data Sources

The data for our study were derived from 3 sources of preexisting de-identified data described below: US mortality data, US Census population data, and US Census county income data. The study protocol was approved by the Harvard School of Public Health Institutional Review Board.

Mortality Data

We obtained the US mortality data from the National Center for Health Statistics (see eAppendix 1 for technical details, http://links.lww.com/EDE/A787). The 1960–1967 data[22] were individual-level records for calendar year of death, age, gender, race/ethnicity, and cause of death, which we aggregated to the county level based on county identifiers. We additionally manually located and identified the correct county code for each of the 3073 counties and assigned the corresponding standard Federal Information Processing Standard code,[19] because the records did not use the post-1968 standard county codes. We extracted from the US Compressed Mortality Files corresponding data for 1968–2009, already aggregated to the county level, and assigned the standard county codes.[23] Following federal definitions,[20,21] we set premature mortality as death before 65 years of age, a cut point that provides conservative estimates for inequities in premature mortality in more recent periods (see eAppendix 2 for sensitivity considerations, http://links.lww.com/EDE/A787).

Population Data

For the 1960–1967 period, the denominator data were as follows: (1) annual population counts, by age, gender, and race/ethnicity, aggregated to the county level, which we obtained from the 1960 US Census and the 1970 US Census[24]; and (2) estimated counts for 1961–1967, based on linear interpolation (see eAppendix 1 for technical details, http://

links.lww.com/EDE/A787). We obtained data on the yearly population counts for 1968–2009 from the Compressed Mortality Files.[23]

County Income Data

We used US census decennial 1960–2000 county-level data on median family income,[25] which we adjusted for inflation and regional cost of living.[26] We could not use racial/ethnic-specific county income data (or data on black–white differences in county income) because these data are available starting only in 1975.[25] We used linear interpolation for intercensal years and extrapolated for 2001–2009 based on the slope for 1990–2000. Missingness due to counties lacking income data was minimal (<1%).

Measurement: State-Level Exposure and the Populations Exposed

Exposure Data: Jim Crow Versus Non-Jim Crow Polity—We defined exposure in relation to the state-level laws distinguishing between polities—that is, entities defined by their policies not geography.[19,27,28] The key distinction (Figure 1) pertained to states that did (n = 21 plus District of Columbia) versus did not (n = 29) have legal racial discrimination overturned by the 1964 US Civil Rights Act,[12,13] hereafter referred to as the Jim Crow versus non-Jim Crow polities, with these designations independent of geographic location (ie, Jim Crow polity not restricted solely to the US South; see detailed rational in eAppendix 2, http://links.lww.com/EDE/A787). Within the Jim Crow polity, additional laws sanctioned racial discrimination at the county- and city-level.[12]

Populations Exposed: Classification of Race/Ethnicity—For our analyses, the populations exposed were restricted to persons designated “black” and “white” in the mortality and population data. The only exception is for the 1960–1967 US national mortality data[22] which, as is well-documented,[21,22] designated people only as “white” and “non-white.” We accordingly followed standard practice, reclassifying “non-white” persons as “black.”[21] Supporting this as a reasonable approach is the fact that in 1960, 92% of US “non-white” persons were black, and mortality rates of these 2 groups were almost identical.[21] New Jersey death certificates did not identify race/ethnicity in 1962 and 1963, precluding the use of these 2 years’ data (<3% of the US population).

Statistical Analysis

We first conducted descriptive analyses, for which we calculated the annual age-standardized premature mortality rate (deaths before 65 years of age) for 1960–2009, standardized to the year 2000 standard million,[29] for the total US black and white population, overall and stratified by Jim Crow polity. We then plotted these data by time period (1960–1964, 1965–1969, …, 2000–2004, 2005–2009) for: (1) the total US black and white population, along with the absolute difference for “black–white”; and (2) the US black and white population, stratified by Jim Crow polity, along with the absolute differences between the 2 polities (separately for the black and white population) and for “black–white” (within each polity).

We then fit a series of 5 hierarchical age–period–cohort models.[3–5] In Poisson log-linear models for mortality rates, we modeled age as a fixed quadratic effect and assumed that the

age effects were the same across groups (in this case, persons in the Jim Crow versus non-Jim Crow polity, within racial/ethnic groups), a constraint justified by assuming that the age effects in an age–period–cohort model can be validly interpreted as the residual (biologically driven) age effects shared by all humans, with any additional cross-polity differences (within racial/ethnic groups) due to period and birth cohort. Period and cohort effects were specified as independent, normally distributed, random effects; the estimated random effects are interpretable in relation to the average effect across periods or cohorts, accordingly.[6]

Moreover, Jim Crow laws and their implementation varied by state and county,[12,13] as did resources and efforts to ameliorate their impacts once these laws were abolished.[13] Recognizing this, we took a multilevel approach to modeling state- and county-level variation by including normally distributed random state and county effects. All models were fit using penalized quasi-likelihood in SAS PROC GLIM-MIX[30] (see computer code in eAppendix 3, http://links.lww.com/EDE/A787).

We (1) fit models with random effects for period and cohort (model 1), and then added, sequentially: (2) Jim Crow-by-period and Jim Crow-by-cohort interactions (model 2); (3) state-level random effects (model 3); (4) county-level random intercepts (model 4); and (5) county median family income quintile as a fixed effect (model 5). In these models, the random effects are assumed to be independent. The final form of model 5, showing all parameters estimated, is as follows:

$$
\begin{gathered}
y_{ijklm} \sim Poisson\left(\mu_{ijklm}\right) \\
\log\left(\mu_{ijklm}\right) = \log\left(\eta_{ijklm}\right) + \beta_0 + \beta_1 age_i + \beta_2 age_i^2 + \beta_3 JC_l + \beta_4 income_m + p_j + JC_l \times q_j + c_k + JC_l \times d_k + u_l + v_m \\
p_j \sim N\left(0, \sigma_p^2\right) \\
q_j \sim N\left(0, \sigma_q^2\right) \\
c_k \sim N\left(0, \sigma_c^2\right) \\
d_k \sim N\left(0, \sigma_d^2\right) \\
u_l \sim N\left(0, \sigma_u^2\right) \\
v_m \sim N\left(0, \sigma_v^2\right)
\end{gathered}
$$

where

- μ_{ijklm} is the expected mortality count and population count from age stratum i in period j and cohort k in county m from state l;
- p_j and q_j are normally distributed random period and period-Jim Crow-state interaction terms, respectively;
- c_k and d_k are normally distributed random cohort and cohort-Jim Crow-state interaction terms, respectively;
- u_l is a normally distributed random state effect;
- v_m is a normally distributed random county effect; and
- "income" refers to county income quintile.

We assessed model fit using pseudo-Bayesian information criterion (BIC) goodness-of-fit statistics (expressed as the difference from that for the best fitting model)[30] for each of the 5 candidate models fit to the data.

RESULTS

Figure 1 provides a map of the Jim Crow and non-Jim Crow polities. Indicating the magnitude of population exposure in 1960, the proportion of the population residing in the Jim Crow polity was 36% of the total US population (all racial/ethnic groups combined) and 63% of the US black population; in 2010, these proportions were 43% and 60%, respectively. The number of deaths (before 65 years of age) and person-years at risk (before 65 years of age), by age, period, and cohort, for the US black and white population, stratified by Jim Crow polity, are provided in eTable 1 (http://links.lww.com/EDE/A787). These numbers were, for black Jim Crow, 3.6 million deaths and 760 million person-years; for black non-Jim Crow, 2.9 million deaths and 617 million person-years; for white Jim Crow, 10.1 million deaths and 3.3 billion person-years; and for white non-Jim Crow, 16.7 million deaths and 5.7 billion person-years. To situate the study findings, Figure 2 presents the age-standardized (2000 million standard) premature mortality rates for the US black and white population, stratified by Jim Crow polity; these rates declined in all groups over time, especially between 1960 and 1980 (see eTables 2 and 3 [http://links.lww.com/EDE/A787] for exact annual mortality rates, which had high precision due to the large sample size). In 1960, the age-standardized premature mortality rates for the black and white populations in the Jim Crow polities were 854 and 798 per 100,000 and in the non-Jim Crow polity 413 and 411 per 100,000, respectively. In 2009, they were 387 and 361 per 100,000, respectively, in the Jim Crow polity and 244 and 199 per 100,000 in the non-Jim Crow polity. Suggestive of racial/ethnic differences in Jim Crow period effects, for the black population Figure 2 shows a temporal pattern of, first, a difference (higher Jim Crow–related mortality), no difference, then smaller re-emerging difference (higher Jim Crow), whereas for the white population, there is no Jim Crow difference in the earlier years, followed by the emergence of a small difference (higher Jim Crow). Throughout, the absolute black–white difference was of similar magnitude in the Jim Crow and non-Jim Crow polities, with a consistently 2-fold excess in black risk, on par with the overall rate among the non-Jim Crow white population.

Tables 1 and 2 present the formal results of the hierarchical age–period–cohort models (Table 1, black population; Table 2, white population). Comparing across the 5 models, model estimates for the period, cohort, Jim Crow-by-period, and Jim Crow-by-cohort effects (model 2) were minimally altered, among both the black and the white population, by inclusion of a state-level random effect (model 3). Adding county random effects (model 4) likewise had little impact, with one notable exception: especially for 1960–1964 and also for 1965–1969, it reduced the period effects and increased the Jim Crow-by-period effects, especially for the black population. Thus, comparing model 3 with model 4, the period effect among the black population for 1960–1964 declined from a mortality rate ratio (MRR) of 1.55 (95% confidence interval [CI] = 1.28–1.88) to 1.28 (95% CI = 1.10–1.50), a 28% reduction in the point estimate, and the Jim Crow-by-period effect for 1960–1964 increased from 1.03 (95% CI = 0.99–1.08) to 1.19 (95% CI = 1.13–1.26), a 16% increase. By contrast,

among the white population, the corresponding shifts were, for the 1960–1964 period effect, from 1.52 (95% CI = 1.29–1.79) to 1.42 (95% CI = 1.21–1.67), a 7% reduction, and for the 1960–1964 Jim Crow-by-period effect, from 1.01 (95% CI = 0.98–1.03) to 1.05 (95% CI = 1.02–1.08), a 4% increase.

Additional inclusion of county income data (model 5) had little effect on the period, cohort, and Jim Crow-by-period and Jim Crow-by-cohort effects. Even so, county income was notably associated with the risk of premature mortality in both the black and white population, with effects larger for the black population, whose MRRs ranged from 1.05 to 1.22, comparing the second highest and lowest quintiles to the highest quintile; for the white population, the corresponding range was 1.03–1.08. We accordingly summarize key results in relation to model 5, which provided the best fit for the white population, even as model 2 provided the best fit for the black population but whose pseudo-BICs across models encompassed a narrower range.

As shown in model 5, within a context of declining period effects for both the black and white population, the Jim Crow-by-period effects varied by race/ethnicity. For the black population, the relative risk for this interaction effect: (1) was largest for 1960–1964 (MRR = 1.15 [95% CI = 1.09–1.22]), when the period effect was high (1.32 [95% CI = 1.12–1.55]), translating to an overall period-specific Jim Crow effect MRR of 1.27; (2) equaled ~1.1 for 2000–2009, when the period effect was under 1; (3) was indistinguishable from 1 for 1970–1979 and 1995–1999; and (4) was slightly below 1 for the remaining years. By contrast, for the white population, the relative risk for the Jim Crow-by-period effect exhibited a temporally unstable pattern. It was: (1) largest for 2005–2009 (MRR = 1.08 [95% CI = 1.05–1.11]), when the period effect was under 1; (2) slightly above 1 (MRR ~1.04) for 1960–1964 (when the period effect equaled 1.43 [95% CI = 1.21–1.68]) and also for 2000–2004 (when the period effect equaled 0.78 [95% CI = 0.67–0.92]); (3) indistinguishable from 1 for 1970–1979 and 1990–1994; and (4) slightly lower than 1 for 1980–1994.

With regard to cohort effects, among both the black and the white populations, the relative risks were generally lowest in the earliest and latter part of the 20th century CE (MRR < 1) and were highest in the 1960s (MRR ~ 1.2 for both groups) and again in 2006–2009 (black MRR =1.48 [95% CI = 1.27–1.73]; white MRR = 1.37 [95% CI = 1.23–1.52]). The Jim Crow-by-cohort interaction effects, however, varied by race/ethnicity. Among the black population, the relative risks for these interaction effects: (1) exceeded 1 for birth cohorts from 1901 through 1945 (range = 1.05–1.11), translating to overall cohort-specific Jim Crow effect MRRs of ~1.2 for the 1901 through 1945 birth cohorts; (2) was indistinguishable from 1 for birth cohorts for 1976–1980 and 2001–2009; and (3) was below 1 for the remaining birth cohorts (MRRs ranging from 0.92 to 0.96). Among the white population, however, the relative risks for the Jim Crow-by-cohort interaction effects: (1) exceeded 1 for birth cohorts from 1951 to 1955 (MRR ranging from 1.04 to 1.08); (2) was indistinguishable from 1 for birth cohorts 1926–1950; and (3) was below 1 for the remaining birth cohorts (MRR ranging from 0.87 to 0.96).

DISCUSSION

Our study is the first to apply hierarchical age–period–cohort models to an analysis of US black and white premature mortality rates in relation to the abolition of Jim Crow. The analysis offers compelling evidence that the elimination of legal racial discrimination in the United States in 1964 had beneficial effects for the US black population in relation to period and birth cohort effects, even as it was insufficient to eliminate the 2-fold excess for black premature mortality that endured throughout the 50 years studied, from 1960 to 2009, in both the Jim Crow and the non-Jim Crow polities. Specifically, in models that took into account random period, cohort, state, and county effects and fixed county income effects, within the black population: (1) the largest Jim Crow-by-period interaction occurred in 1960–1964 (MRR = 1.15 [95%: CI = 1.09–1.22]), yielding the largest overall period-specific Jim Crow effect MRR of 1.27; and (2) the most elevated Jim Crow-by-cohort effects occurred for birth cohorts from 1901 through 1945 (range = 1.05–1.11), translating to the largest overall cohort-specific Jim Crow effect MRRs for the 1901–1945 birth cohorts (MRR ~ 1.2). No similar patterns occurred among the white population.

Together, these findings suggest that not only did Jim Crow and its abolition differentially affect the risk of premature mortality among the US black and white population but it did so above and beyond county differences in income level, eg, as influenced by the mid-1960s "War on Poverty."[13] The greater impact of including county random effects on the 1960–1964 and 1965–1969 periods and Jim Crow-by-period effects for the black compared with white population additionally suggests that county-level variation in the enforcement and abolition of Jim Crow likely mattered.[12,13]

Valid interpretation of our findings requires consideration of both study strengths and limitations. Empirically, one key strength is our use of national US mortality and census data. Thus, evidence indicates that since 1960, 99% of all US deaths and births have been registered[31] and that the US census undercount (disproportionately affecting persons who are impoverished or of color) has decreased substantially between 1960 and 2000, from 3.1% to 0.1% for the total population and from 6.6% to 2.8% for the black population.[32] The net effect would be to deflate, not inflate, more recent estimates of higher mortality rates among the US black and also lower income populations.

Two additional strengths pertain to our choice of exposure and outcome. First, by focusing on abolition of Jim Crow, we introduce a rarely addressed societal determinant of health causally implicated in the social patterning of health among the US black and white population,[14–19] as opposed to focusing on these latter 2 groups as solely demographic categories. Second, premature mortality has 2 advantages as an outcome: not only is it a key indicator of population health[20,21] but it is also unaffected by well-known problems affecting accuracy of cause-of-death data (especially problematic for populations lacking adequate access to health care, such as for the black population in the Jim Crow states) and temporal changes in codes for cause-specific mortality. Premature mortality is also unlikely to be affected by age misclassification, because most errors, especially for the US black population, affect reported age for persons older than 65 years among persons born in the earlier part of the 20th century CE.[33] Moreover, misclassification of "white" and "black"

deaths in US mortality data has been shown to be minor,[34] and the effect of having had to equate the "non-white" with the "black" population for 1960–1967 would be to yield a conservative estimate of the actual black mortality rate, because evidence indicates that mortality rates were higher in the black compared with non-black "non-white" population.[21,35]

Despite advantages of using the hierarchical age–period–cohort models (assuming valid a priori theoretical assumptions regarding the data-generating process),[2] we note that the most likely explanation for the more extreme results observed for the birth cohorts at the margins in our study population, as observed for both the black and white populations (ie, MRR ~ 0.8 for the 1901–1905 birth cohort and MRR ~ 1.4 to 1.5 for the 2006–2009 birth cohort), has to do with the small numbers and restricted age ranges for these cohorts. Thus, the 1901–1905 birth cohort included only persons who were 60–64 years of age in the 1960–1964 period, and the 2006–2009 birth cohort included only persons who were ≤4 years of age (ie, a group whose age-specific mortality rates are on par with those of persons 35–39 years of age; see eTable 2, http://links.lww.com/EDE/A787). If this explanation is correct—an assumption that warrants empirical testing—it underscores that statistical models cannot, by themselves, make up for a dearth of data at the margins.

Our results make 2 novel contributions to the small body of prior research, suggesting that abolition of Jim Crow was beneficial for the health of the US black population.[14–19] First, methodologically, we extend prior research on the health impact of the abolition of Jim Crow by using new hierarchical age–period–cohort models, with a critical innovation being our model's ability to take into account state and county variation within the Jim Crow and non-Jim Crow polities. Second, and more substantively, our analytic approach focuses on a societal determinant of health rarely addressed in public health research[27]: political incorporation, referring to which societal groups have secured sufficient legal recognition and rights to be able to affect the content of policies, their implementation, and their health effects.[27,28] By directly incorporating data on structural aspects of racism, over the relevant societal and individual time frames of exposure, our study extends the existing research investigating how racism affects health, which primarily has focused on contemporary associations between self-reported experiences of racial discrimination and health.[14,36] Likely pathways pertinent to abolition of Jim Crow include increased access to medical care, in conjunction with reductions in economic deprivation and in the physical and psychological violence used to enforce Jim Crow.[14–19] Testing these hypothesized pathways will require richer data sets that combine micro- and macrolevel data on health status and its social determinants.

Beyond this, by including Jim Crow as an explicit exposure, our study underscores the importance of empirically analyzing political determinants of racial/ethnic patterns of health, that is, race relations between groups.[11,14] The approach we have taken thus differs from conventional research, which treats race/ethnicity as if it were principally an a priori trait of individuals,[11,14] as exemplified by investigations—including on premature mortality—that analyze race/ethnicity solely as a demographic category or that model "percent black" as a determinant of mortality rates,[37–39] without including any data on race relations. The results

likewise support the need for research investigating variation in the magnitude of black excess mortality by place, even after taking into account socioeconomic position.[40]

In conclusion, by rigorously applying hierarchical age–period–cohort models to study social inequalities in health, our study provides novel and compelling evidence of the enduring impact of Jim Crow and its abolition on the risk of premature mortality among the US black population, as reflected in both period and cohort effects. Even so, abolition of Jim Crow has been insufficient to eliminate the persistent 2-fold black excess risk of premature mortality evident, both in states that did and did not have Jim Crow laws, over the 50 years (1960–2009) encompassed by our study.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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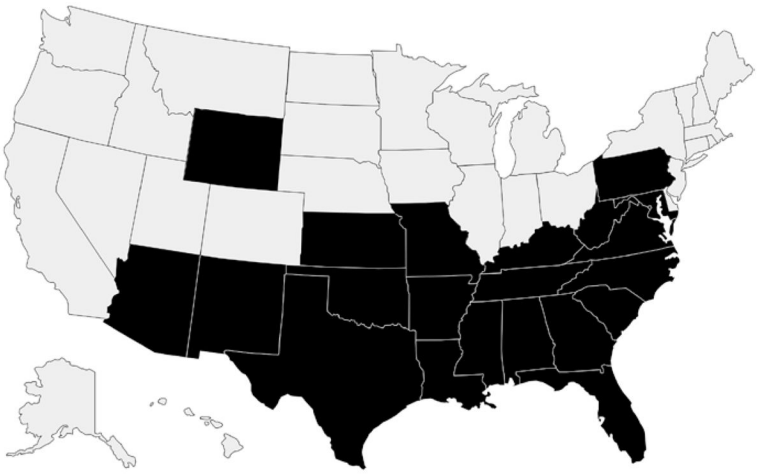

FIGURE 1.
In black, the US states with legal racial discrimination outlawed by the 1964 US Civil Rights Act. (“Jim Crow states”).

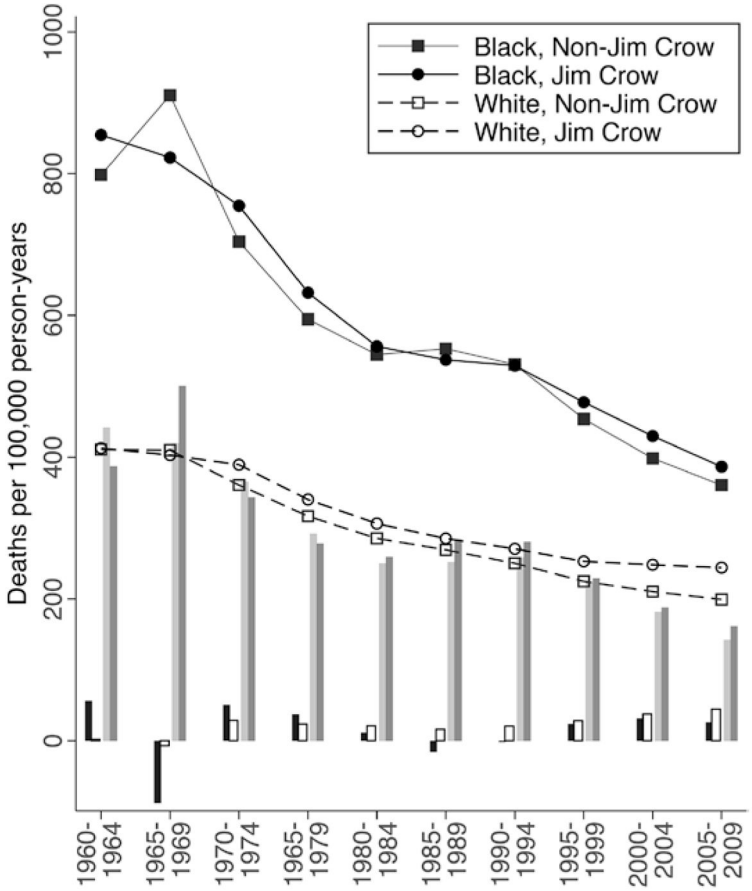

FIGURE 2.

US age-standardized premature mortality rates (death before 65 years of age, standardized to the 2000 standard million), 1960–2009: black and white population by Jim Crow polity. Difference between Jim Crow and non-Jim crow areas: for blacks, black bars; for whites, white bars. Difference between blacks and whites: for Jim Crow areas, light gray bars; for non-Jim Crow areas, medium gray bars.

TABLE 1

Hierarchical Age–Period–Cohort Models for Premature Mortality: US Black Population, 1960–2009, in Relation to Jim Crow Polity, State, County, and County Income Quintile

	Model 1		Model 2		Model 3		Model 4		Model 5	
	(Fixed Age) + (Random Period) + (Random Cohort)		Model 1 + (JC × Period) + (JC × Cohort)		Model 2 + (Random State)		Model 3 + (Random County)		Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
Fixed effects										
Intercept	0.00	(0.00–0.00)	0.00	(0.00–0.00)	0.00	(0.00–0.00)	0.00	(0.00–0.00)	0.00	(0.00–0.00)
Agecat	0.74	(0.73–0.75)	0.74	(0.73–0.75)	0.74	(0.73–0.75)	0.74	(0.73–0.75)	0.74	(0.73–0.75)
$Agecat^2$	1.04	(1.04–1.04)	1.04	(1.04–1.04)	1.04	(1.04–1.04)	1.04	(1.04–1.04)	1.04	(1.04–1.04)
Jim Crow polity			1.01	(0.96–1.06)	1.11	(1.00–1.24)	1.16	(1.03–1.30)	1.10	(0.99–1.23)
Income quintile										
1 (lowest)									1.22	(1.21–1.23)
2									1.19	(1.18–1.20)
3									1.13	(1.12–1.13)
4									1.06	(1.05–1.06)
5 (highest)[a]									1.00	
Period effects										
1960–1964	1.61	(1.33–1.94)	1.58	(1.30–1.93)	1.55	(1.28–1.87)	1.28	(1.10–1.50)	1.34	(1.12–1.55)
1965–1969	1.54	(1.28–1.86)	1.65	(1.36–2.00)	1.63	(1.35–1.97)	1.49	(1.28–1.73)	1.52	(1.30–1.78)
1970–1974	1.22	(1.02–1.46)	1.20	(0.99–1.46)	1.20	(1.00–1.44)	1.21	(1.04–1.40)	1.22	(1.04–1.43)
1975–1979	1.00	(0.84–1.20)	1.00	(0.82–1.20)	0.99	(0.83–1.20)	1.01	(0.87–1.17)	1.01	(0.87–1.18)
1980–1984	0.88	(0.74–1.06)	0.90	(0.74–1.09)	0.90	(0.75–1.08)	0.92	(0.80–1.06)	0.92	(0.79–1.08)
1985–1989	0.91	(0.76–1.09)	0.95	(0.78–1.15)	0.95	(0.79–1.14)	0.98	(0.85–1.14)	0.98	(0.84–1.14)
1990–1994	0.94	(0.79–1.12)	0.96	(0.80–1.16)	0.97	(0.80–1.16)	1.01	(0.87–1.16)	1.00	(0.86–1.17)
1995–1999	0.85	(0.71–1.02)	0.83	(0.69–1.01)	0.84	(0.69–1.01)	0.88	(0.76–1.02)	0.86	(0.74–1.01)
2000–2004	0.76	(0.64–0.92)	0.73	(0.60–0.89)	0.74	(0.61–0.89)	0.78	(0.67–0.90)	0.76	(0.65–0.90)
2005–2009	0.67	(0.56–0.81)	0.64	(0.53–0.78)	0.65	(0.54–0.79)	0.69	(0.59–0.81)	0.68	(0.57–0.80)
JC × period (NJC)										
1960–1964			1.02	(0.97–1.06)	1.03	(0.99–1.08)	1.19	(1.13–1.26)	1.15	(1.09–1.22)
1965–1969			0.87	(0.83–0.91)	0.87	(0.83–0.91)	0.94	(0.89–0.99)	0.91	(0.86–0.96)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	(Fixed Age) + (Random Period) + (Random Cohort)		Model 1 + (JC × Period) + (JC × Cohort)		Model 2 + (Random State)		Model 3 + (Random County)		Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
1970–1974			1.01	(0.96–1.06)	1.01	(0.96–1.05)	0.98	(0.93–1.04)	0.97	(0.92–1.02)
1975–1979			1.00	(0.96–1.05)	1.00	(0.96–1.05)	0.98	(0.93–1.03)	0.97	(0.92–1.02)
1980–1984			0.97	(0.93–1.02)	0.97	(0.92–1.01)	0.94	(0.89–0.99)	0.94	(0.89–0.99)
1985–1989			0.93	(0.89–0.97)	0.93	(0.89–0.97)	0.90	(0.85–0.95)	0.90	(0.86–0.95)
1990–1994			0.97	(0.92–1.01)	0.96	(0.92–1.01)	0.94	(0.89–0.99)	0.95	(0.90–1.00)
1995–1999			1.05	(1.00–1.10)	1.05	(1.00–1.10)	1.02	(0.97–1.08)	1.04	(0.98–1.10)
2000–2004			1.10	(1.05–1.16)	1.10	(1.05–1.15)	1.07	(1.02–1.13)	1.10	(1.04–1.16)
2005–2009			1.11	(1.06–1.16)	1.10	(1.05–1.16)	1.08	(1.02–1.14)	1.10	(1.05–1.17)
Cohort effects										
1901–1905	0.80	(0.68–0.94)	0.78	(0.67–0.92)	0.79	(0.67–0.92)	0.80	(0.69–0.94)	0.80	(0.68–0.94)
1906–1910	0.84	(0.72–0.97)	0.84	(0.73–0.98)	0.85	(0.73–0.98)	0.86	(0.74–0.99)	0.86	(0.74–0.99)
1911–1915	0.99	(0.86–1.14)	0.99	(0.87–1.14)	0.99	(0.87–1.14)	1.00	(0.87–1.14)	1.00	(0.87–1.14)
1916–1920	1.00	(0.88–1.14)	0.99	(0.87–1.12)	0.99	(0.88–1.13)	1.00	(0.88–1.13)	0.99	(0.88–1.13)
1921–1925	1.19	(1.06–1.34)	1.19	(1.06–1.33)	1.19	(1.06–1.33)	1.19	(1.06–1.33)	1.18	(1.05–1.33)
1926–1930	1.22	(1.09–1.36)	1.20	(1.07–1.33)	1.20	(1.07–1.33)	1.20	(1.07–1.33)	1.19	(1.07–1.33)
1931–1935	1.16	(1.05–1.29)	1.13	(1.02–1.25)	1.13	(1.02–1.25)	1.13	(1.02–1.25)	1.13	(1.02–1.25)
1936–1940	1.11	(1.01–1.22)	1.08	(0.98–1.19)	1.08	(0.98–1.19)	1.08	(0.98–1.19)	1.08	(0.98–1.19)
1941–1945	1.08	(0.98–1.18)	1.07	(0.98–1.16)	1.06	(0.97–1.16)	1.07	(0.98–1.17)	1.07	(0.98–1.17)
1946–1950	1.05	(0.97–1.15)	1.08	(0.99–1.17)	1.07	(0.99–1.17)	1.08	(0.99–1.18)	1.08	(0.99–1.18)
1951–1955	1.08	(1.00–1.18)	1.13	(1.04–1.23)	1.13	(1.04–1.23)	1.14	(1.04–1.23)	1.13	(1.04–1.23)
1956–1960	0.99	(0.91–1.08)	1.02	(0.94–1.11)	1.02	(0.94–1.11)	1.03	(0.94–1.12)	1.03	(0.94–1.12)
1961–1965	1.25	(1.15–1.37)	1.27	(1.17–1.38)	1.27	(1.17–1.38)	1.28	(1.17–1.39)	1.28	(1.17–1.39)
1966–1970	1.15	(1.05–1.26)	1.17	(1.07–1.27)	1.17	(1.07–1.27)	1.17	(1.07–1.27)	1.17	(1.07–1.28)
1971–1975	1.03	(0.94–1.13)	1.02	(0.93–1.12)	1.02	(0.92–1.12)	1.02	(0.92–1.12)	1.02	(0.92–1.12)
1976–1980	0.99	(0.89–1.09)	0.97	(0.88–1.08)	0.97	(0.88–1.07)	0.97	(0.87–1.07)	0.97	(0.88–1.07)
1981–1985	0.89	(0.79–0.99)	0.88	(0.79–0.98)	0.88	(0.79–0.98)	0.87	(0.78–0.97)	0.88	(0.79–0.98)
1986–1990	0.80	(0.71–0.90)	0.82	(0.73–0.92)	0.82	(0.73–0.92)	0.81	(0.72–0.91)	0.82	(0.72–0.92)
1991–1995	0.73	(0.64–0.83)	0.75	(0.66–0.86)	0.75	(0.66–0.85)	0.74	(0.66–0.84)	0.75	(0.66–0.85)
1996–2000	0.65	(0.56–0.74)	0.65	(0.57–0.75)	0.65	(0.57–0.75)	0.64	(0.56–0.74)	0.64	(0.56–0.74)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	(Fixed Age) + (Random Period) + (Random Cohort)		Model 1 + (JC × Period) + (JC × Cohort)		Model 2 + (Random State)		Model 3 + (Random County)		Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
2001–2005	0.88	(0.76–1.02)	0.86	(0.74–1.00)	0.86	(0.74–1.00)	0.86	(0.74–0.99)	0.86	(0.74–0.99)
2006–2009	1.53	(1.31–1.80)	1.49	(1.27–1.74)	1.49	(1.28–1.75)	1.48	(1.26–1.72)	1.48	(1.27–1.73)
JC × cohort (NJC)										
1901–1905			1.09	(1.07–1.12)	1.10	(1.07–1.13)	1.11	(1.08–1.14)	1.11	(1.08–1.14)
1906–1910			1.04	(1.01–1.06)	1.04	(1.02–1.07)	1.05	(1.02–1.08)	1.05	(1.02–1.08)
1911–1915			1.04	(1.02–1.07)	1.05	(1.02–1.07)	1.06	(1.03–1.09)	1.06	(1.03–1.09)
1916–1920			1.05	(1.03–1.08)	1.06	(1.03–1.08)	1.07	(1.04–1.10)	1.07	(1.04–1.10)
1921–1925			1.04	(1.02–1.06)	1.04	(1.02–1.07)	1.05	(1.02–1.08)	1.05	(1.02–1.08)
1926–1930			1.06	(1.03–1.08)	1.06	(1.04–1.09)	1.07	(1.04–1.09)	1.07	(1.04–1.09)
1931–1935			1.08	(1.05–1.10)	1.08	(1.05–1.11)	1.08	(1.05–1.11)	1.08	(1.05–1.11)
1936–1940			1.07	(1.04–1.09)	1.07	(1.04–1.10)	1.07	(1.04–1.10)	1.07	(1.04–1.10)
1941–1945			1.03	(1.01–1.06)	1.04	(1.01–1.06)	1.04	(1.01–1.06)	1.04	(1.01–1.06)
1946–1950			0.97	(0.95–0.99)	0.97	(0.95–1.00)	0.97	(0.94–1.00)	0.97	(0.94–1.00)
1951–1955			0.93	(0.91–0.95)	0.93	(0.91–0.95)	0.93	(0.90–0.95)	0.93	(0.90–0.95)
1956–1960			0.94	(0.92–0.96)	0.94	(0.92–0.96)	0.94	(0.91–0.96)	0.94	(0.91–0.96)
1961–1965			0.97	(0.94–0.99)	0.96	(0.94–0.99)	0.96	(0.94–0.99)	0.96	(0.94–0.99)
1966–1970			0.96	(0.94–0.99)	0.96	(0.94–0.98)	0.96	(0.94–0.99)	0.96	(0.94–0.99)
1971–1975			1.01	(0.98–1.03)	1.00	(0.98–1.03)	1.00	(0.98–1.03)	1.00	(0.98–1.03)
1976–1980			1.00	(0.98–1.03)	1.00	(0.98–1.03)	1.00	(0.97–1.02)	1.00	(0.97–1.02)
1981–1985			0.98	(0.96–1.01)	0.98	(0.95–1.00)	0.97	(0.95–1.00)	0.97	(0.95–1.00)
1986–1990			0.93	(0.91–0.95)	0.92	(0.90–0.95)	0.92	(0.89–0.95)	0.92	(0.90–0.95)
1991–1995			0.91	(0.88–0.93)	0.90	(0.88–0.93)	0.90	(0.88–0.93)	0.90	(0.88–0.93)
1996–2000			0.95	(0.92–0.97)	0.94	(0.91–0.97)	0.94	(0.91–0.97)	0.94	(0.91–0.97)
2001–2005			0.99	(0.96–1.02)	0.98	(0.96–1.01)	0.98	(0.95–1.01)	0.98	(0.95–1.01)
2006–2009			1.00	(0.97–1.03)	0.99	(0.96–1.02)	0.98	(0.95–1.02)	0.98	(0.95–1.01)
Variance components										
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Period	0.06	0.03	0.07	0.03	0.06	0.03	0.06	0.04	0.06	0.04
Period × JC			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Model 1 (Fixed Age) + (Random Period) + (Random Cohort)		Model 2 Model 1 + (JC × Period) + (JC × Cohort)		Model 3 Model 2 + (Random State)		Model 4 Model 3 + (Random County)		Model 5 Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
Cohort	0.03	0.01	0.03	0.01	0.03	0.01	0.02	0.00	0.02	0.00
Cohort × JC			0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
State					0.01	0.00	0.02	0.01	0.02	0.01
County							0.06	0.00	0.05	0.00
					Pseudo-BIC					
	18,483		0		113,517		385,703		337,440	

JC indicates Jim Crow polity; NJC, non-Jim Crow polity; agecat and agecat^2, age and its quadratic term; BIC, Bayesian information criterion.

[a] Reference category.

TABLE 2

Hierarchical Age–Period–Cohort Models for Premature Mortality: US White Population, 1960–2009, in Relation to Jim Crow Polity, State, County, and County Income Quintile

	Model 1		Model 2		Model 3		Model 4		Model 5	
	(Fixed Age) + (Random Period) + (Random Cohort)		Model 1 + (JC × Period) + (JC × Cohort)		Model 2 + (Random State)		Model 3 + (Random County)		Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
Fixed effects										
Intercept	0.00	(0.00–0.00)	0.00	(0.00–0.00)	0.00	(0.00–0.00)	0.00	(0.00–0.00)	0.00	(0.00–0.00)
Agecat	0.73	(0.72–0.74)	0.73	(0.72–0.74)	0.73	(0.72–0.74)	0.73	(0.72–0.74)	0.73	(0.72–0.74)
$Agecat^2$	1.04	(1.04–1.04)	1.04	(1.04–1.04)	1.04	(1.04–1.04)	1.04	(1.04–1.04)	1.04	(1.04–1.04)
Jim Crow polity			1.09	(1.05–1.13)	1.15	(1.08–1.22)	1.18	(1.07–1.29)	1.16	(1.06–1.27)
Income quintile										
1 (lowest)									1.08	(1.07–1.08)
2									1.07	(1.07–1.08)
3									1.05	(1.05–1.06)
4									1.03	(1.03–1.03)
5 (highest)[a]									1.00	
Period effects										
1960–1964	1.52	(1.30–1.78)	1.55	(1.31–1.83)	1.52	(1.29–1.79)	1.42	(1.21–1.67)	1.43	(1.21–1.68)
1965–1969	1.39	(1.19–1.62)	1.43	(1.21–1.69)	1.42	(1.21–1.67)	1.39	(1.19–1.63)	1.39	(1.19–1.64)
1970–1974	1.21	(1.04–1.41)	1.21	(1.03–1.42)	1.21	(1.03–1.42)	1.22	(1.04–1.43)	1.22	(1.04–1.43)
1975–1979	1.06	(0.91–1.23)	1.07	(0.91–1.25)	1.07	(0.91–1.25)	1.08	(0.92–1.26)	1.08	(0.92–1.26)
1980–1984	0.95	(0.82–1.10)	0.96	(0.81–1.12)	0.96	(0.82–1.12)	0.97	(0.83–1.13)	0.97	(0.83–1.13)
1985–1989	0.91	(0.78–1.06)	0.92	(0.78–1.08)	0.93	(0.79–1.08)	0.94	(0.80–1.09)	0.94	(0.80–1.10)
1990–1994	0.88	(0.76–1.02)	0.89	(0.76–1.04)	0.89	(0.76–1.04)	0.90	(0.77–1.05)	0.90	(0.77–1.05)
1995–1999	0.83	(0.71–0.96)	0.82	(0.70–0.97)	0.82	(0.70–0.97)	0.83	(0.71–0.98)	0.83	(0.71–0.97)
2000–2004	0.80	(0.68–0.93)	0.77	(0.65–0.91)	0.78	(0.66–0.91)	0.78	(0.67–0.92)	0.78	(0.67–0.92)
2005–2009	0.74	(0.63–0.87)	0.71	(0.60–0.84)	0.71	(0.60–0.84)	0.72	(0.61–0.84)	0.72	(0.61–0.84)
JC × period (NJC)										
1960–1964			0.99	(0.97–1.02)	1.01	(0.98–1.03)	1.05	(1.02–1.08)	1.04	(1.01–1.08)
1965–1969			0.96	(0.94–0.98)	0.96	(0.94–0.98)	0.97	(0.94–1.00)	0.97	(0.94–1.00)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	(Fixed Age) + (Random Period) + (Random Cohort)		Model 1 + (JC × Period) + (JC × Cohort)		Model 2 + (Random State)		Model 3 + (Random County)		Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
1970–1974			1.03	(1.00–1.05)	1.02	(1.00–1.05)	1.01	(0.98–1.04)	1.01	(0.98–1.04)
1975–1979			1.00	(0.98–1.02)	1.00	(0.97–1.02)	0.98	(0.96–1.01)	0.98	(0.96–1.01)
1980–1984			0.98	(0.96–1.01)	0.98	(0.96–1.00)	0.97	(0.94–1.00)	0.97	(0.94–1.00)
1985–1989			0.96	(0.93–0.98)	0.95	(0.93–0.98)	0.95	(0.92–0.98)	0.95	(0.92–0.98)
1990–1994			0.96	(0.94–0.99)	0.96	(0.94–0.99)	0.96	(0.93–0.99)	0.96	(0.93–0.99)
1995–1999			1.00	(0.98–1.02)	1.00	(0.98–1.02)	1.00	(0.97–1.03)	1.00	(0.97–1.03)
2000–2004			1.04	(1.02–1.07)	1.04	(1.02–1.07)	1.04	(1.01–1.08)	1.05	(1.02–1.08)
2005–2009			1.08	(1.05–1.10)	1.08	(1.05–1.10)	1.08	(1.04–1.11)	1.08	(1.05–1.11)
Cohort effects										
1901–1905	0.82	(0.71–0.94)	0.83	(0.73–0.95)	0.83	(0.72–0.94)	0.80	(0.72–0.89)	0.80	(0.72–0.89)
1906–1910	0.94	(0.82–1.06)	0.96	(0.84–1.08)	0.95	(0.84–1.08)	0.93	(0.84–1.03)	0.93	(0.84–1.03)
1911–1915	1.05	(0.94–1.19)	1.07	(0.95–1.20)	1.07	(0.95–1.20)	1.05	(0.96–1.15)	1.05	(0.96–1.15)
1916–1920	1.02	(0.92–1.14)	1.03	(0.93–1.15)	1.03	(0.93–1.15)	1.02	(0.94–1.11)	1.02	(0.94–1.11)
1921–1925	1.10	(1.00–1.22)	1.10	(1.00–1.22)	1.10	(1.00–1.22)	1.10	(1.02–1.19)	1.10	(1.02–1.19)
1926–1930	1.11	(1.01–1.22)	1.10	(1.00–1.20)	1.10	(1.00–1.20)	1.10	(1.02–1.18)	1.10	(1.02–1.18)
1931–1935	1.07	(0.98–1.17)	1.06	(0.97–1.15)	1.06	(0.97–1.15)	1.06	(0.99–1.13)	1.06	(0.99–1.13)
1936–1940	1.03	(0.95–1.12)	1.01	(0.94–1.09)	1.01	(0.94–1.10)	1.02	(0.95–1.08)	1.02	(0.95–1.08)
1941–1945	0.98	(0.91–1.06)	0.97	(0.90–1.05)	0.98	(0.90–1.05)	0.98	(0.92–1.04)	0.98	(0.92–1.04)
1946–1950	0.96	(0.89–1.03)	0.95	(0.89–1.02)	0.95	(0.89–1.02)	0.96	(0.91–1.02)	0.96	(0.91–1.02)
1951–1955	1.05	(0.97–1.12)	1.03	(0.96–1.10)	1.03	(0.96–1.11)	1.04	(0.98–1.10)	1.04	(0.98–1.10)
1956–1960	1.02	(0.95–1.09)	0.98	(0.92–1.06)	0.99	(0.92–1.06)	1.00	(0.94–1.05)	1.00	(0.94–1.05)
1961–1965	1.30	(1.20–1.34)	1.29	(1.20–1.38)	1.29	(1.20–1.39)	1.30	(1.23–1.38)	1.30	(1.23–1.38)
1966–1970	1.21	(1.12–1.30)	1.20	(1.12–1.29)	1.20	(1.12–1.30)	1.21	(1.14–1.28)	1.21	(1.14–1.28)
1971–1975	1.12	(1.04–1.22)	1.11	(1.02–1.20)	1.11	(1.02–1.20)	1.11	(1.04–1.18)	1.11	(1.04–1.18)
1976–1980	1.06	(0.97–1.16)	1.05	(0.96–1.14)	1.05	(0.96–1.14)	1.05	(0.98–1.12)	1.05	(0.98–1.12)
1981–1985	1.01	(0.92–1.11)	0.99	(0.91–1.09)	0.99	(0.91–1.09)	1.00	(0.93–1.07)	1.00	(0.93–1.07)
1986–1990	0.91	(0.82–1.00)	0.90	(0.81–0.99)	0.90	(0.81–0.99)	0.90	(0.84–0.98)	0.90	(0.84–0.98)
1991–1995	0.77	(0.69–0.86)	0.78	(0.70–0.86)	0.77	(0.70–0.86)	0.78	(0.72–0.85)	0.78	(0.72–0.85)
1996–2000	0.64	(0.57–0.72)	0.66	(0.59–0.75)	0.66	(0.59–0.74)	0.67	(0.61–0.73)	0.67	(0.61–0.73)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	(Fixed Age) + (Random Period) + (Random Cohort)		Model 1 + (JC × Period) + (JC × Cohort)		Model 2 + (Random State)		Model 3 + (Random County)		Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
2001–2005	0.81	(0.71–0.92)	0.84	(0.74–0.95)	0.83	(0.74–0.94)	0.84	(0.76–0.93)	0.84	(0.76–0.93)
2006–2009	1.32	(1.15–1.52)	1.37	(1.20–1.56)	1.36	(1.19–1.56)	1.37	(1.23–1.52)	1.37	(1.23–1.52)
JC × cohort (NJC)										
1901–1905			0.86	(0.83–0.88)	0.86	(0.84–0.89)	0.88	(0.86–0.90)	0.88	(0.86–0.90)
1906–1910			0.86	(0.84–0.89)	0.86	(0.84–0.89)	0.87	(0.85–0.89)	0.87	(0.85–0.89)
1911–1915			0.89	(0.86–0.91)	0.89	(0.87–0.92)	0.89	(0.87–0.92)	0.89	(0.87–0.92)
1916–1920			0.93	(0.90–0.95)	0.93	(0.90–0.96)	0.93	(0.91–0.95)	0.93	(0.91–0.95)
1921–1925			0.96	(0.93–0.99)	0.96	(0.93–0.99)	0.96	(0.94–0.98)	0.96	(0.94–0.98)
1926–1930			0.99	(0.96–1.02)	0.99	(0.96–1.02)	0.99	(0.96–1.01)	0.99	(0.96–1.01)
1931–1935			1.01	(0.98–1.04)	1.01	(0.98–1.04)	1.01	(0.98–1.03)	1.01	(0.98–1.03)
1936–1940			1.02	(0.99–1.05)	1.02	(0.99–1.05)	1.02	(0.99–1.04)	1.02	(0.99–1.04)
1941–1945			1.01	(0.98–1.04)	1.01	(0.98–1.04)	1.01	(0.98–1.03)	1.01	(0.98–1.03)
1946–1950			1.00	(0.98–1.04)	1.00	(0.97–1.03)	1.00	(0.98–1.02)	1.00	(0.98–1.02)
1951–1955			1.05	(1.02–1.08)	1.04	(1.02–1.08)	1.04	(1.02–1.07)	1.04	(1.02–1.07)
1956–1960			1.10	(1.06–1.13)	1.09	(1.06–1.12)	1.09	(1.06–1.11)	1.09	(1.06–1.11)
1961–1965			1.04	(1.01–1.07)	1.04	(1.01–1.07)	1.03	(1.01–1.06)	1.03	(1.01–1.06)
1966–1970			1.04	(1.01–1.07)	1.04	(1.01–1.07)	1.04	(1.01–1.06)	1.04	(1.01–1.06)
1971–1975			1.07	(1.04–1.10)	1.07	(1.04–1.10)	1.07	(1.04–1.09)	1.07	(1.04–1.09)
1976–1980			1.06	(1.03–1.10)	1.06	(1.03–1.09)	1.06	(1.04–1.09)	1.06	(1.04–1.09)
1981–1985			1.09	(1.06–1.12)	1.08	(1.05–1.12)	1.08	(1.06–1.11)	1.08	(1.06–1.11)
1986–1990			1.08	(1.04–1.11)	1.07	(1.04–1.10)	1.07	(1.05–1.10)	1.07	(1.05–1.10)
1991–1995			1.04	(1.01–1.07)	1.04	(1.01–1.07)	1.04	(1.01–1.06)	1.04	(1.01–1.06)
1996–2000			0.99	(0.96–1.02)	0.99	(0.96–1.02)	0.99	(0.96–1.01)	0.99	(0.96–1.02)
2001–2005			0.99	(0.96–1.02)	0.99	(0.96–1.02)	0.99	(0.96–1.02)	0.99	(0.96–1.02)
2006–2009			0.99	(0.96–1.02)	0.99	(0.96–1.02)	0.99	(0.97–1.02)	0.99	(0.97–1.02)
Variance components										
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Period	0.08	0.040	0.09	0.05	0.09	0.04	0.05	0.03	0.06	0.03
Period × JC			0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00

	Model 1 (Fixed Age) + (Random Period) + (Random Cohort)		Model 2 Model 1 + (JC × Period) + (JC × Cohort)		Model 3 Model 2 + (Random State)		Model 4 Model 3 + (Random County)		Model 5 Model 4 + (Fixed County Income)	
	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)	Exp(β)	(95% CI)
Cohort	0.04	0.013	0.04	0.01	0.04	0.01	0.04	0.01	0.04	0.01
Cohort × JC			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
State					0.03	0.01	0.03	0.01	0.02	0.01
County							0.08	0.00	0.08	0.00
Pseudo-BIC										
	1,129,339		904,290		823,544		12,304		0	

JC indicates Jim Crow polity; NJC, non-Jim Crow polity; agecat and agecat^2, age and its quadratic term; BIC, Bayesian information criterion.

[a]Reference category.