Black-White Mortality Crossover Paradox: Observed Mortality Selection and Heterogeneity in Frailty

PAA 2026 | Racial/Ethnic Inequalities in Mortality

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University of Texas at Austin

May 8, 2026

Black-White differences in mortality in the U.S.

Black-White differences in mortality in the United States are:

- Huge
- Historic
- Ongoing



BRIEF REPORT | SOCIAL SCIENCES

US racial inequality may be as deadly as COVID-19

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71,137 | 70 PDF/EPUB

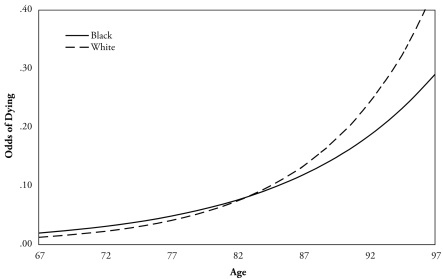
PNAS. Wrigley-Field 2020.

Paradox: Black-White mortality crossover

- Yet — among oldest-old, Black mortality is lower than White mortality (!)

Paradox: Black-White mortality crossover

- Yet — among oldest-old, Black mortality is lower than White mortality (!)
- Black-White mortality crossover is a well-studied demographic **paradox**
- Fundamental to our understanding of **inequality** over the life course
  - Cumulative disadvantage and weathering (Geronimus, 2023)

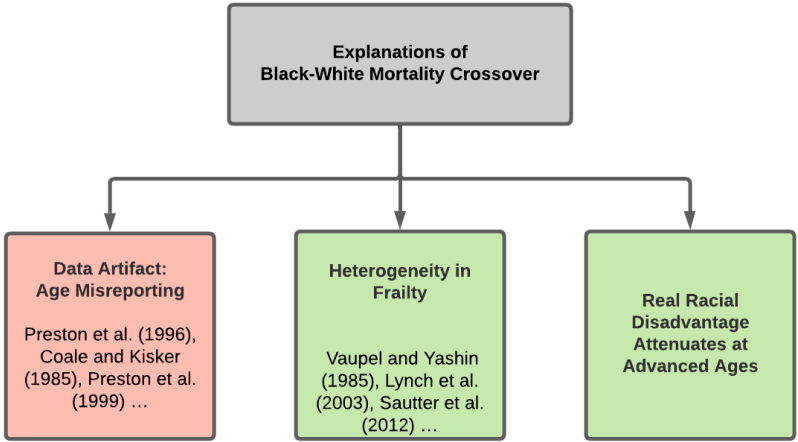


Dupre 2006. *Demography.*

Black-White crossover repeatedly documented

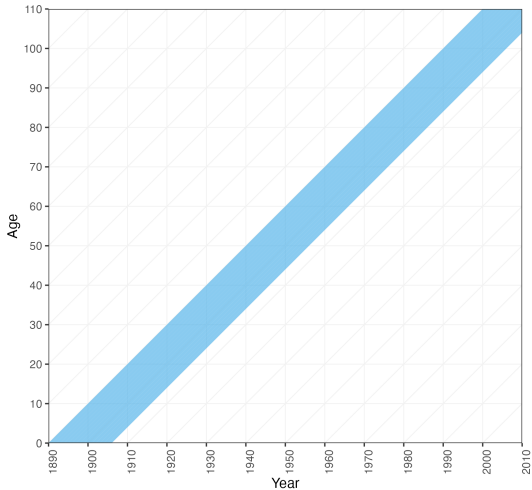
Data Source	Age of Crossover	Covariates	Age Verification	Citation
Tennessee Vital Statistics	74			Sibley (1930)
Evans County Study	85 (f); 80 (m)			Wing et al. (1985)
Medicare Enrollment	88 (f); 86 (m)			Kestenbaum (1992)
U.S. Death Certificates	90 (f); 85 (m)		✓	Preston (1996)
Medicare Enrollment	85–86			Parnell and Owens (1999)
Survey on Asset and Health Dynamics Among the Oldest Old	81			Johnson (2000)
Berkeley Mortality Database	79–87		✓	Lynch, Brown and Harmsen (2003)
Medicare Enrollment	80–85			Arias (2006)
Established Populations for Epidemiologic Studies of the Elderly	83 (f); 79 (m)	Religious Attendance		Dupre, Franzese and Parrado (2006)
Americans' Changing Lives study	80	Education, Income, Neighborhoods		Yao and Robert (2011)
National Health Interview Survey-Linked Mortality Files	85			Masters (2012)
Established Populations for Epidemiologic Studies of the Elderly	83 (f); 79 (m)			Sautter et al. (2012)
NCHS Multiple Cause-of-Death public-use files	87	Education, Income		Fenelon (2013)
National Longitudinal Mortality Study	85			Şahin and Heiland (2017)

Still no consensus on explanation...



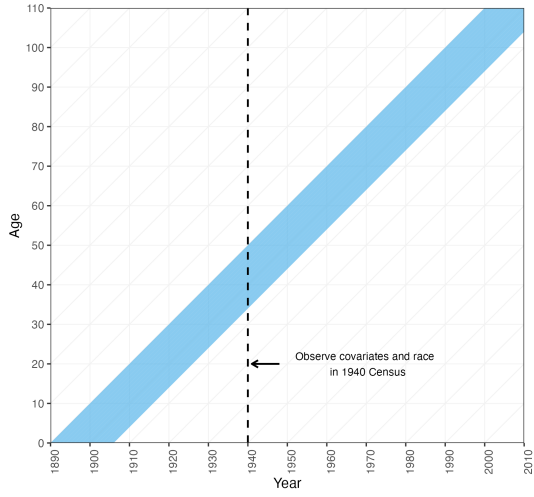
New data allows us to make progress

- CenSoc-DMF: Linked 1940-Census and SS mortality records
- Birth cohorts of 1890-1905
  - $N = 910k$ deaths
- Sample restrictions
  - Men only
  - U.S. born



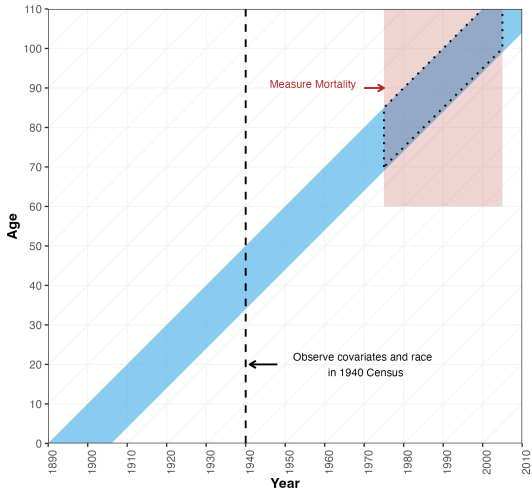
Analytic Sample

- Birth cohorts of 1890-1905
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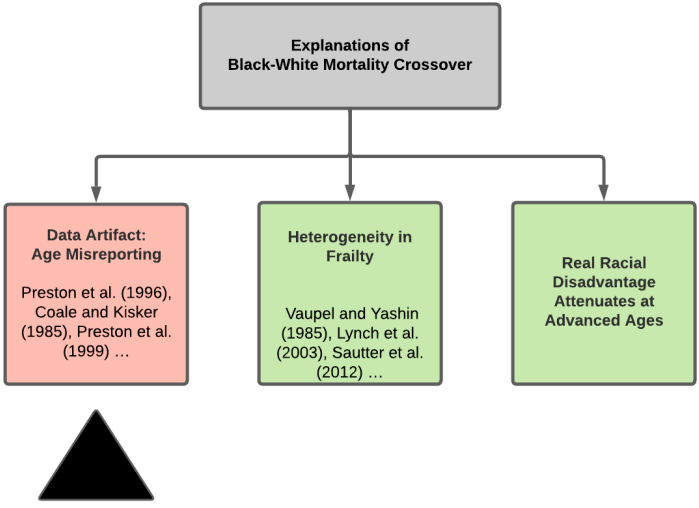


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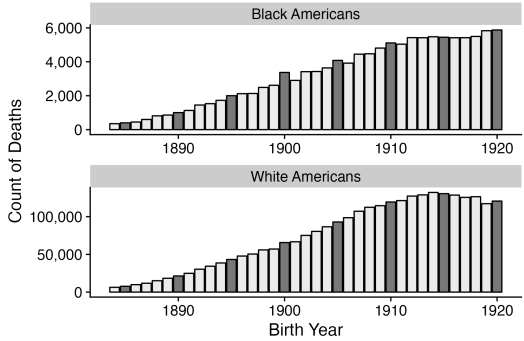
Question 1: Is the crossover a data artifact?



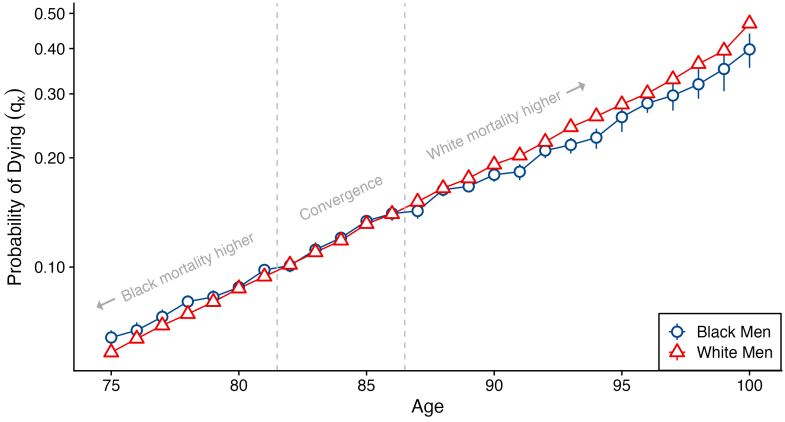
Question 1: Is the crossover a data artifact?

Background: Age of death calculated from date of birth and date of death

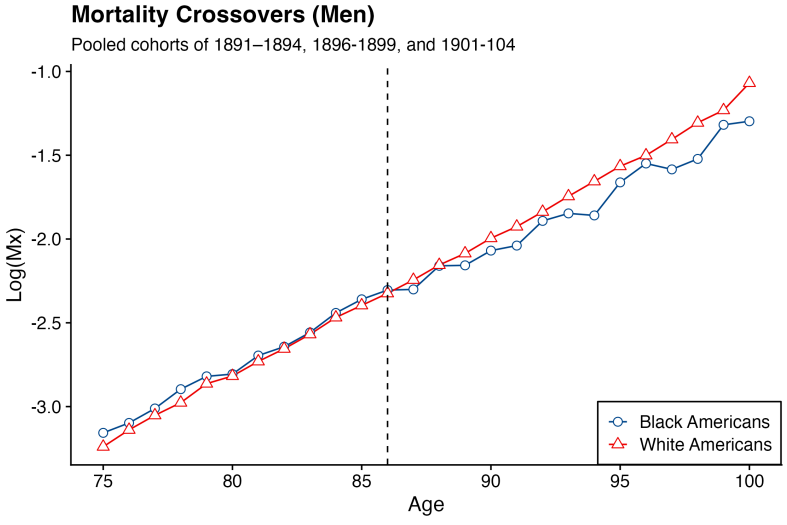
1. Minimal age heaping on birth year...
2. Date of death gets reported immediately (no heaping)
3. Institutional incentive: Social Security wants to accurately track birth date
4. Linkage requires close match on year of birth and Census age



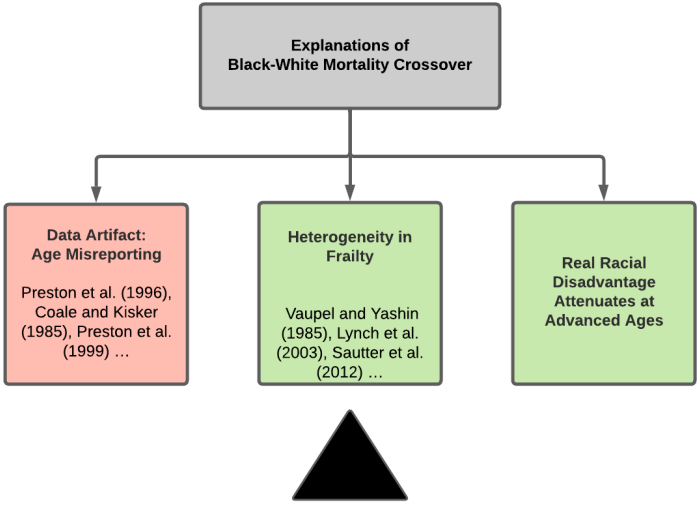
Black-White crossover (extinct cohort method)



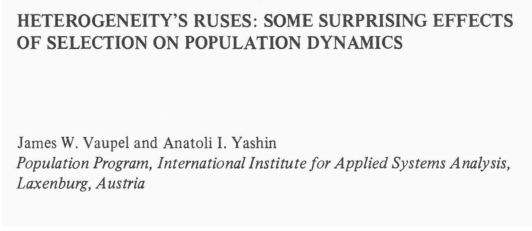
Black-white crossover (extinct cohort method)



Question 2: Is the crossover driven by heterogeneity in frailty?



The theory of heterogeneity in frailty

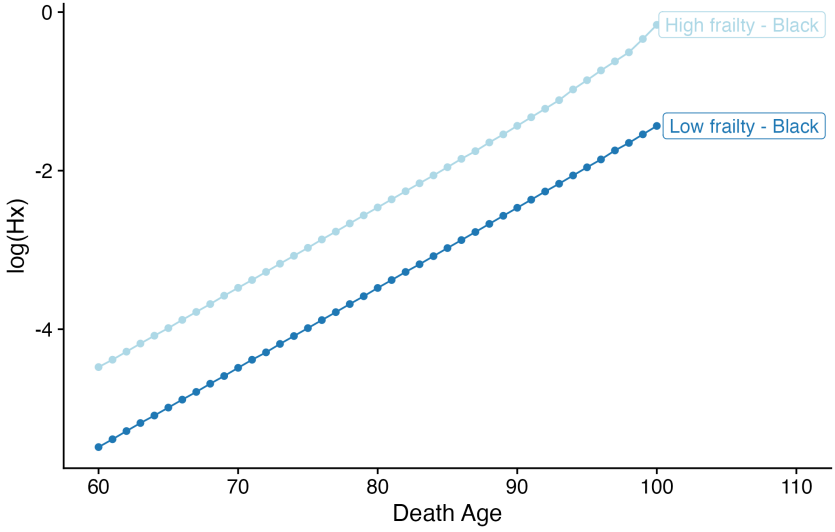


HETEROGENEITY'S RUSES: SOME SURPRISING EFFECTS OF SELECTION ON POPULATION DYNAMICS

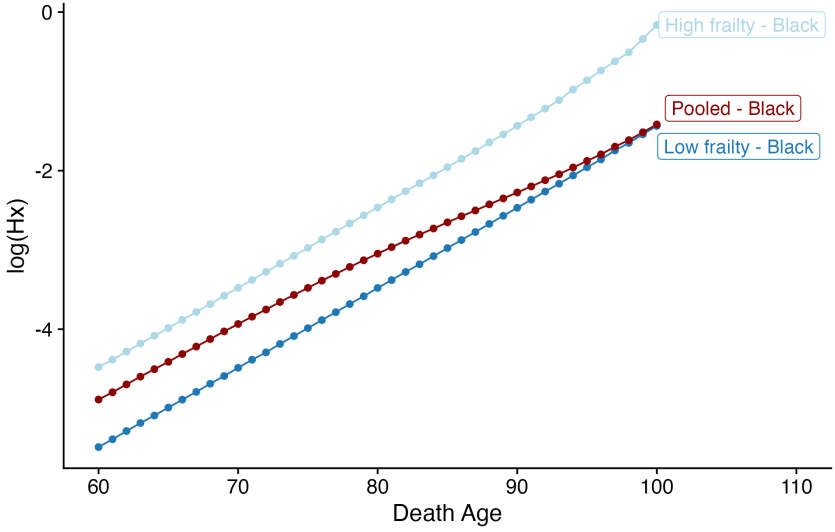
James W. Vaupel and Anatoli I. Yashin
Population Program, International Institute for Applied Systems Analysis, Laxenburg, Austria

- To get a crossover, higher initial mortality population must have **higher variance** in frailty
- As the cohorts age, mortality selection is much stronger for the high mortality, high variance group
- So much stronger, that eventually the frailty of survivors actually crosses

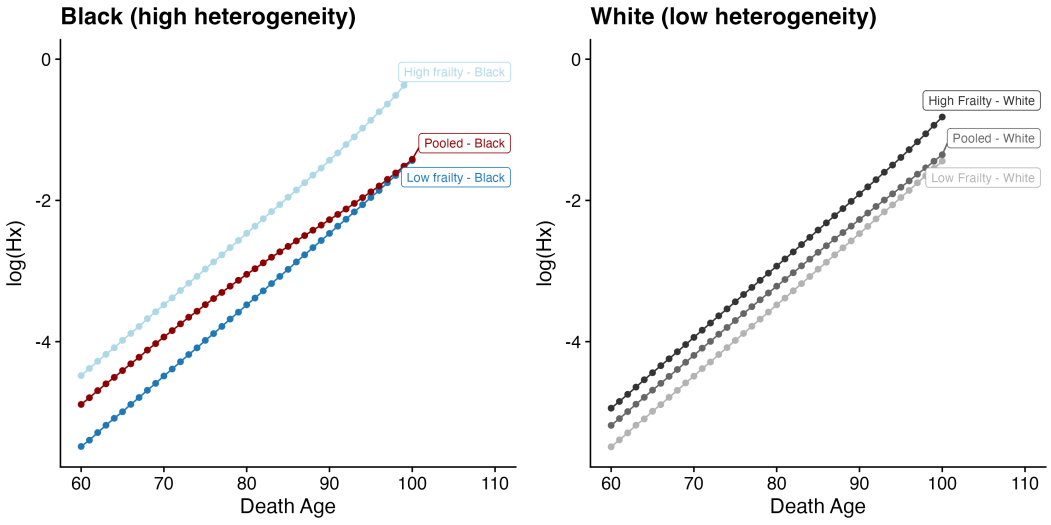
Heterogeneity in frailty (stylized example)



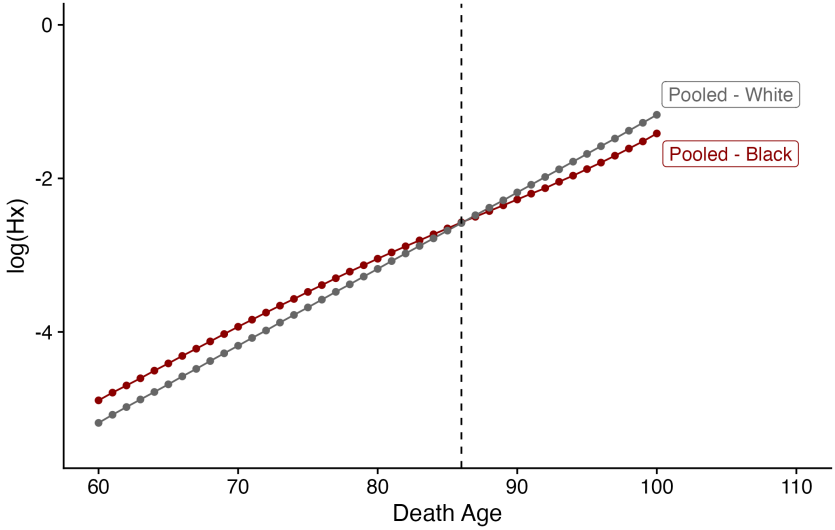
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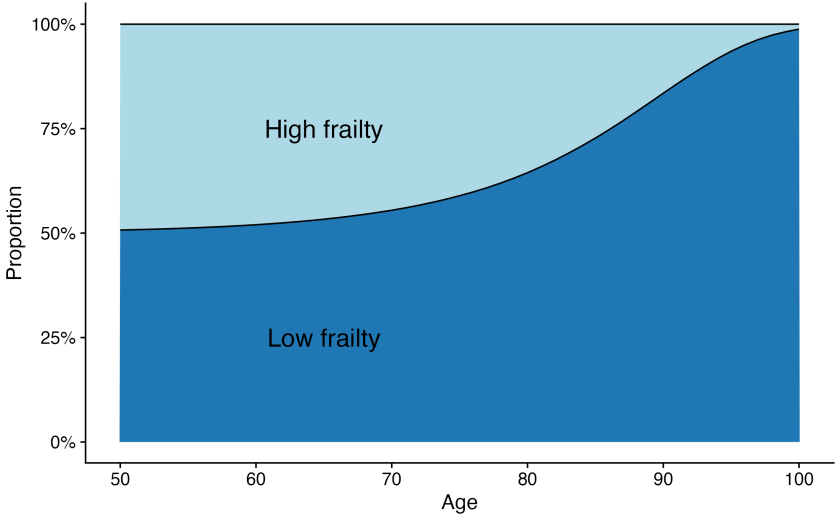
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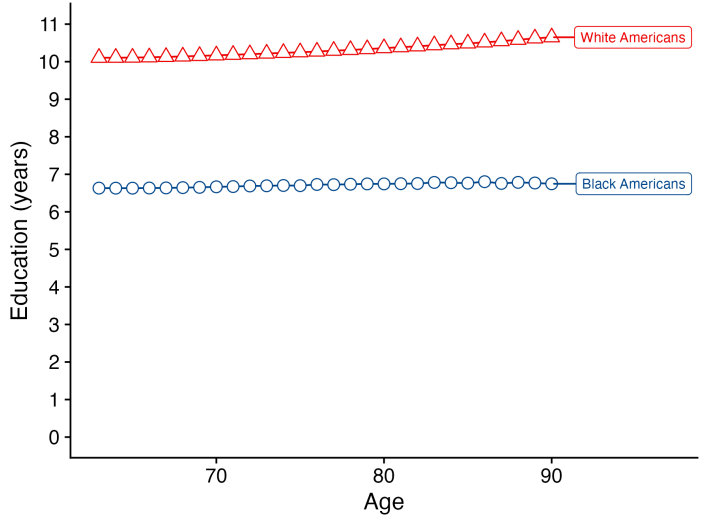
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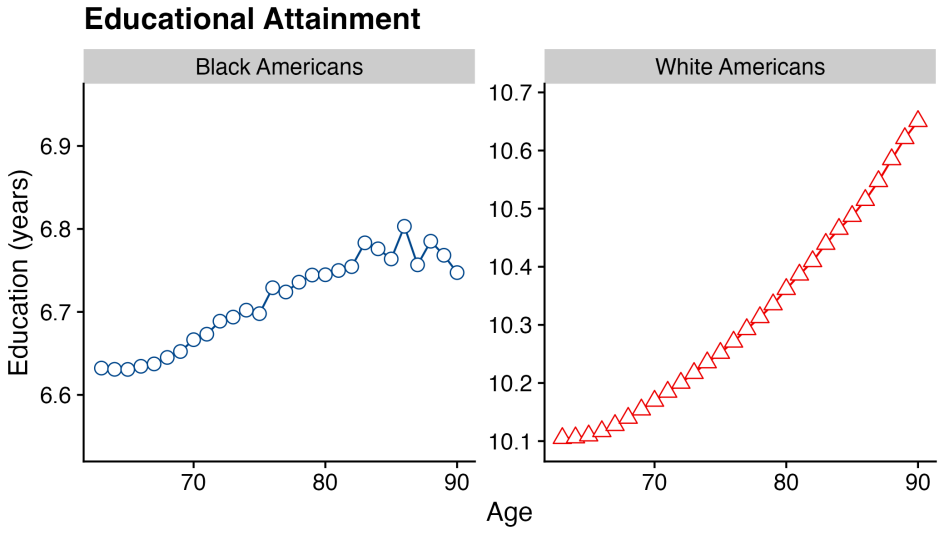
Very dramatic shift in composition of survivors...



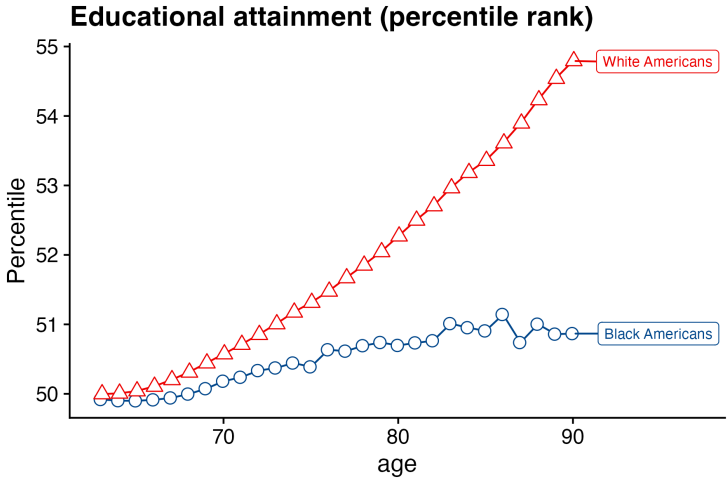
Changing educational composition of survivors



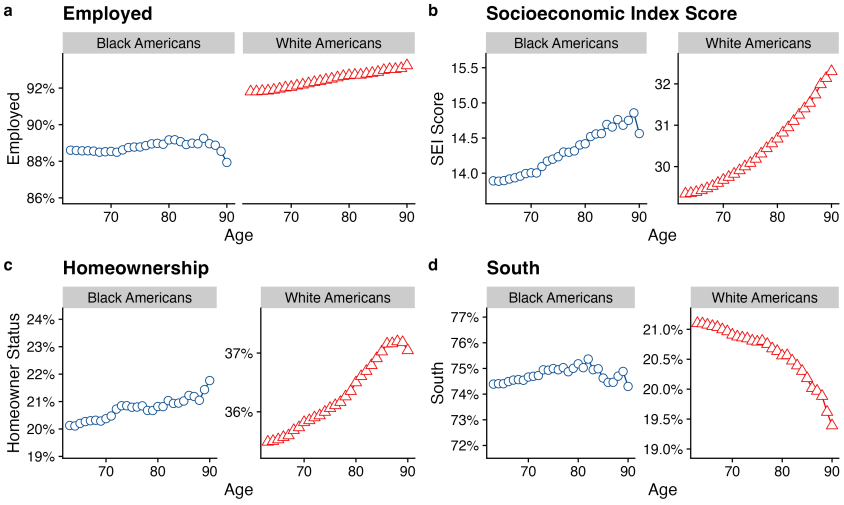
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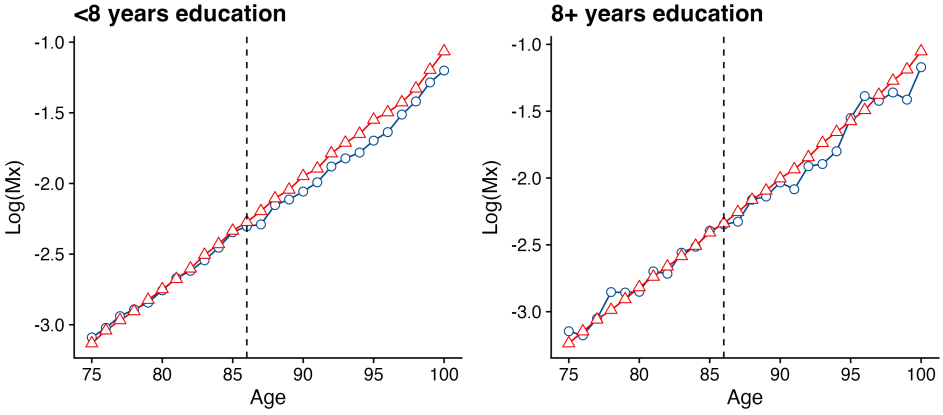
Changing educational composition of survivors (percentile)



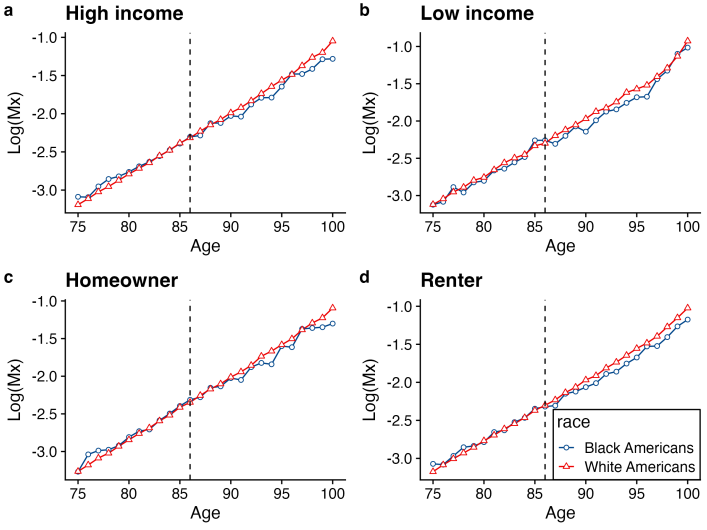
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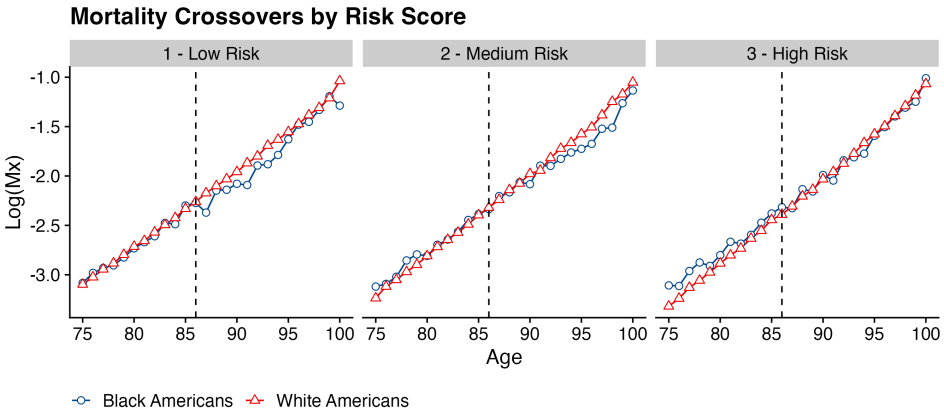
Stratifying by dimensions of frailty



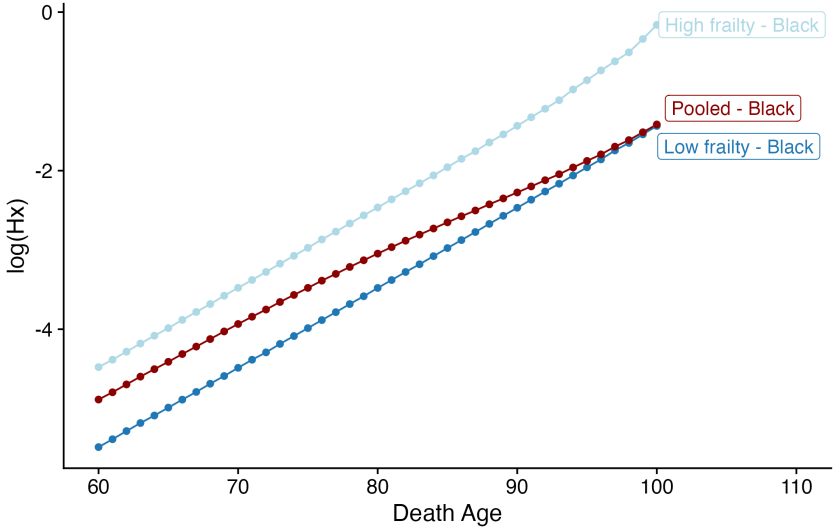
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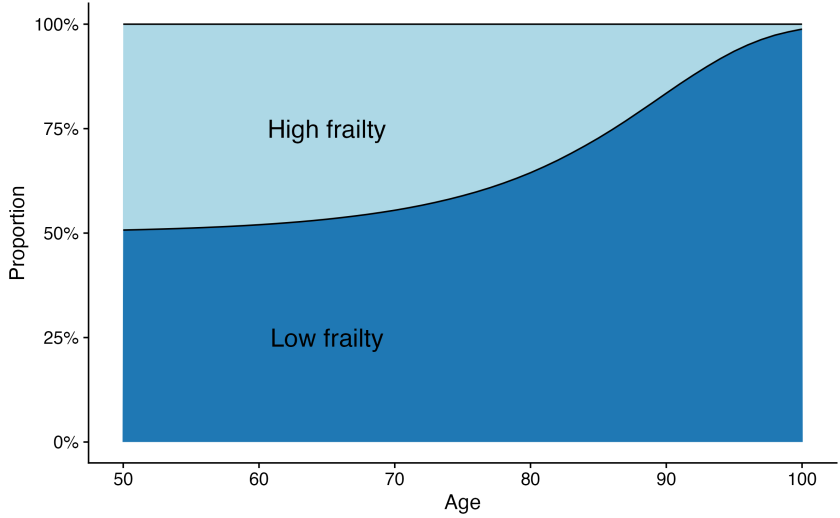
Stratifying on risk score



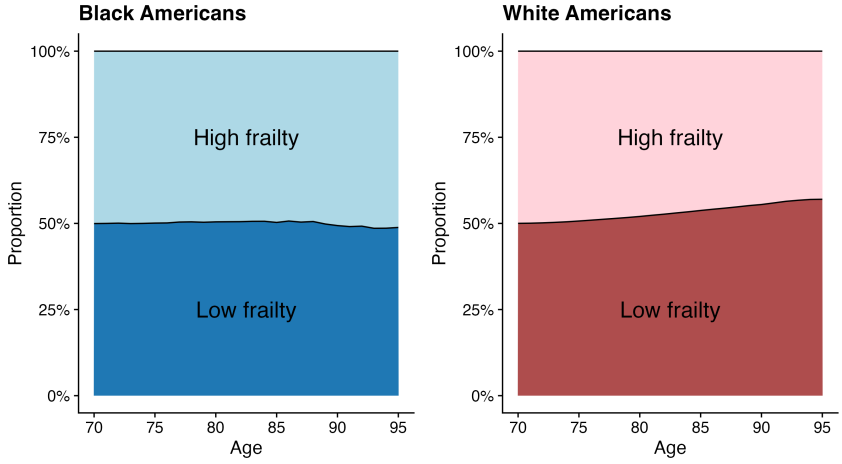
How much selection would we need? (Simulation)



How much selection would we need for Black Americans?



How much selection do we actually observe? Very little



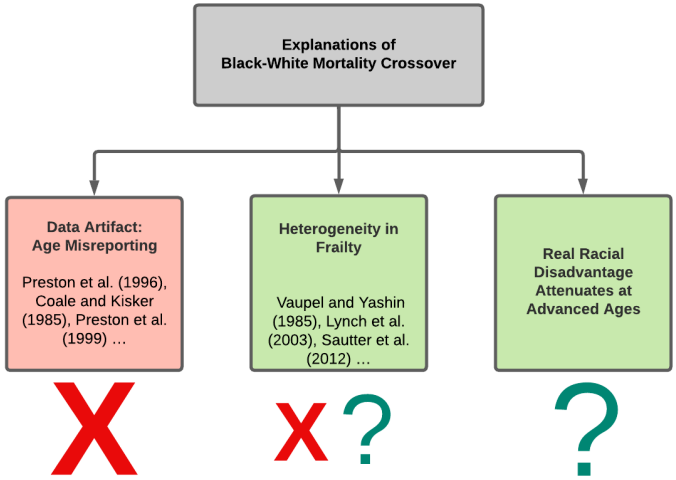
No support for heterogeneity in frailty explanation

1. Very little mortality selection

No support for heterogeneity in frailty explanation

1. Very little mortality selection
2. Mortality selection stronger for White Americans than Black Americans
   - Cause a **widening** — not convergence/crossover — of mortality rates
3. No observable mortality deceleration for Black Americans (bend in mortality curve)

Revisiting explanations...



Conclusions

- Black-White Crossover is real — *not* ***data artifact***

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  - Not educational attainment, not income, not wealth, not risk score
  - However, other dimensions of heterogeneity might be responsible (biomarkers?)

Conclusions

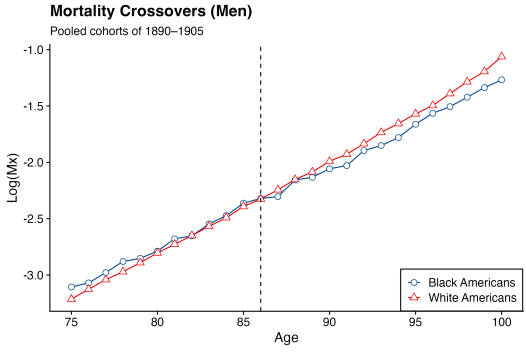
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- New explanations are needed

Thank you — questions?

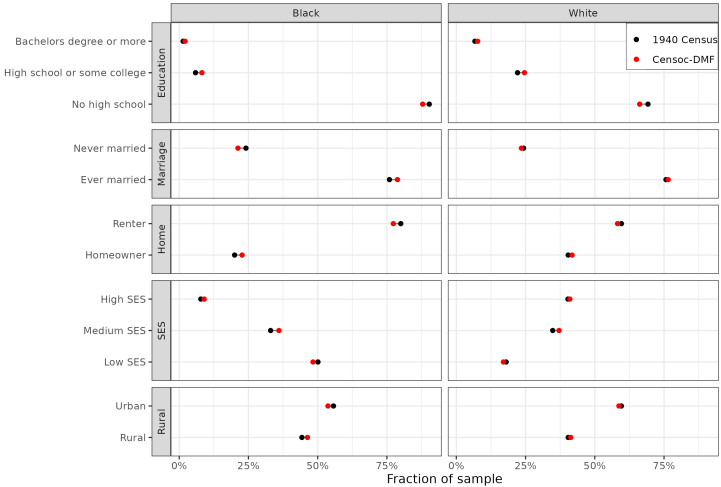
Data: CenSoc.Berkeley.edu

Funding: R01AG058940, R01AG076830

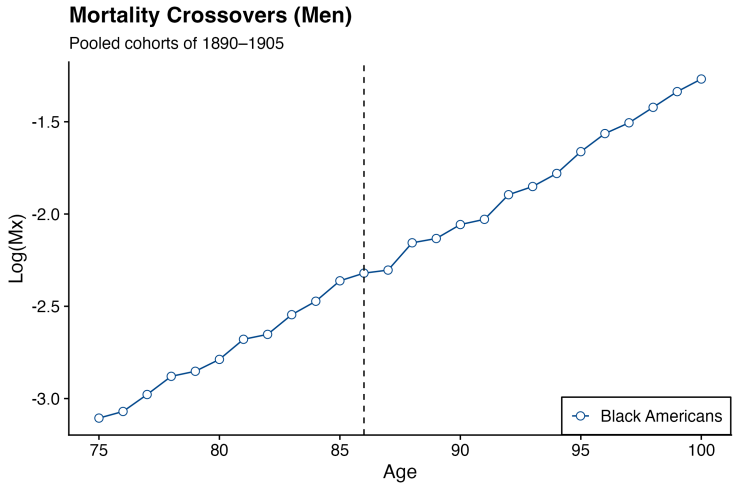
Contact: ✉ casey.breen@austin.utexas.edu



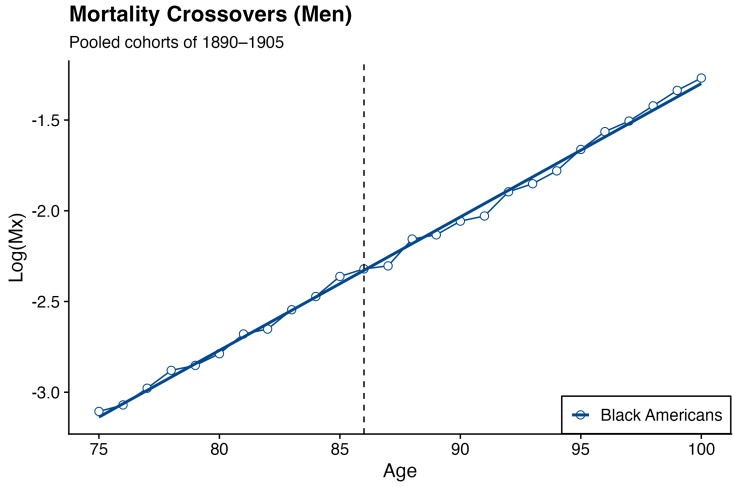
Representativeness



Simple test - visible deceleration? (Bend in curve?)



Perfectly linear...



Birth cohorts of 1890-1905: extinct cohort method

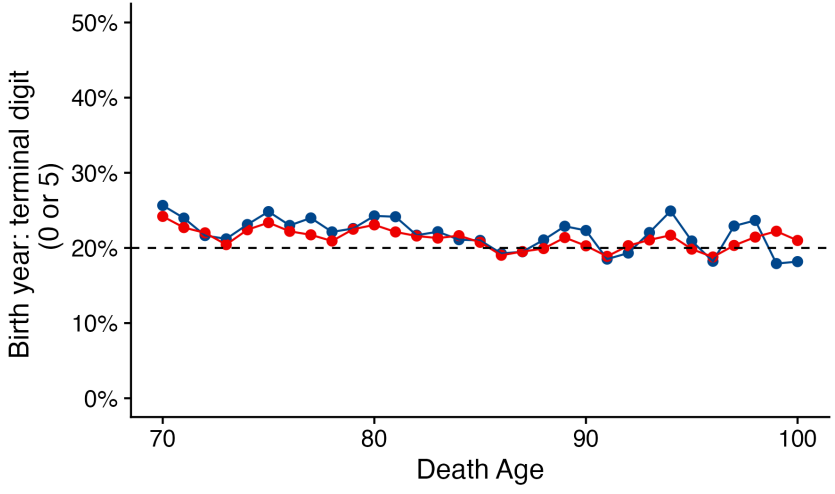
- Assumes that all members of the cohort have died by a certain year
- Uses recorded deaths over time to reconstruct the cohort's survival pattern

$$q_x = \frac{d_x}{\sum_x^\infty d_i} = \frac{d_x}{l_x} \tag{1}$$

where:

- q_x is the probability of dying at age x.
- d_x is number of deaths at age x

Age heaping


50%
40%
30%
20%
10%
0%
Birth year: terminal digit
(0 or 5)
70
80
90
100
Death Age
Black Americans
White Americans

Birth cohorts of 1906-1915: Gompertz Hazard Model

$$h(x) = \mathbf{a}e^{\mathbf{b}.x} \tag{2}$$

- $h(x)$ = hazard at age x. "Force of mortality"

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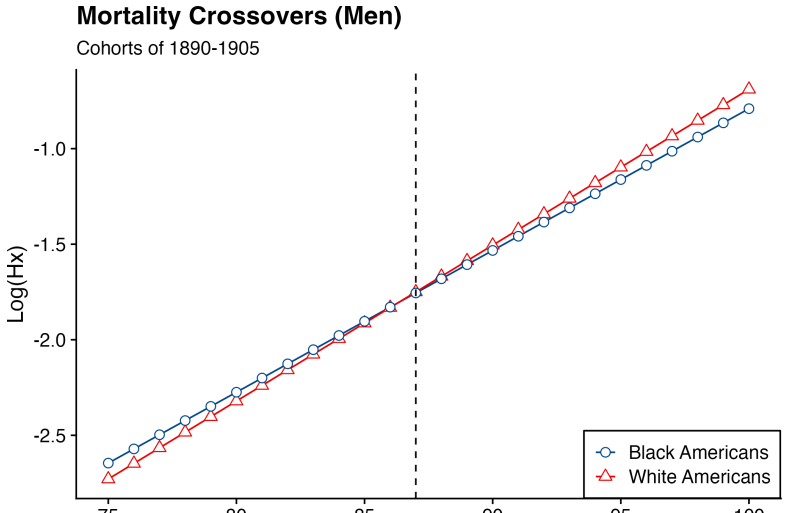
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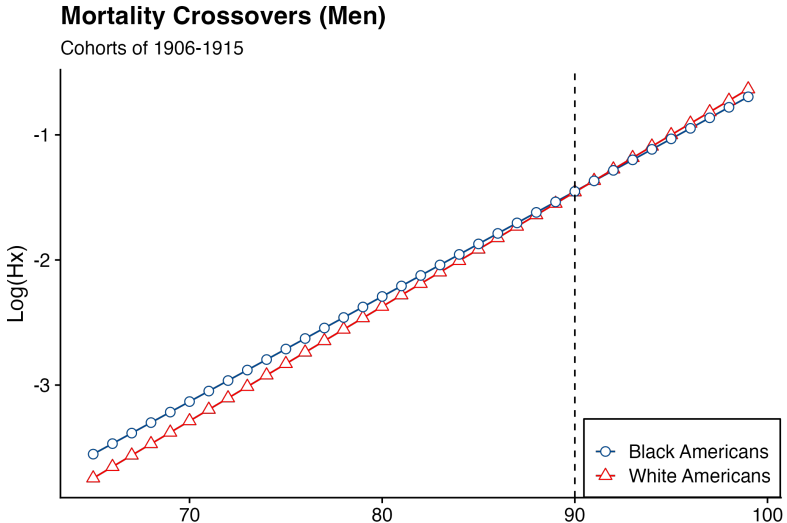
$$h(x) = \mathbf{a}e^{\mathbf{b}x} \tag{2}$$

- $h(x)$ = hazard at age x. "Force of mortality"
- **a is baseline mortality**
- **b is rate of increase of mortality**

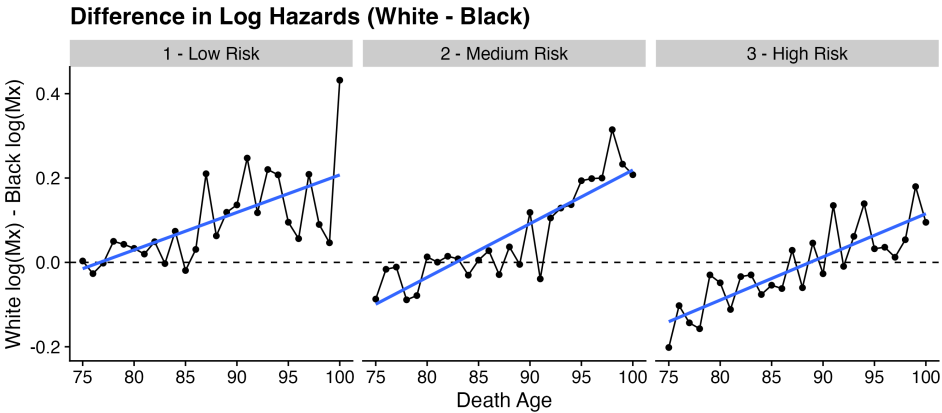
Black-white crossover (Gompertz Hazard Model)



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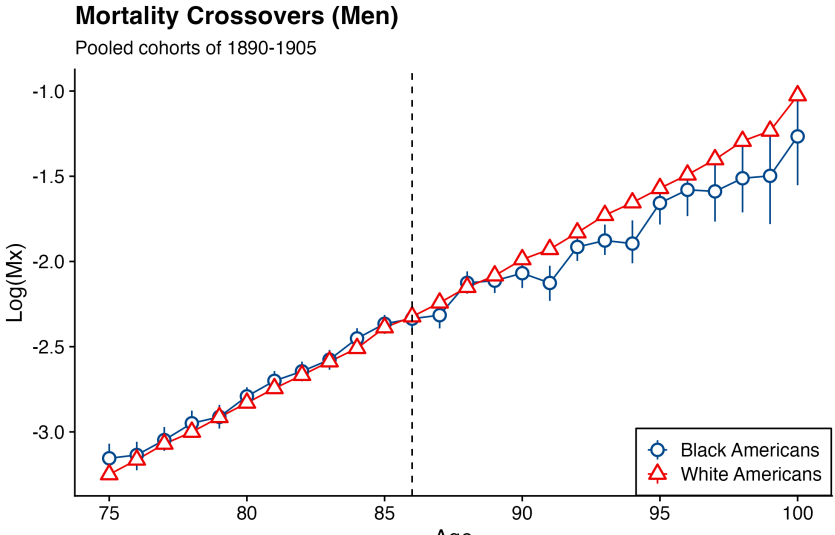
Stratifying on risk score



Representativeness of samples

	General Pop		CenSoc-DMF		CenSoc-DMF Siblings	
	No.	%	No.	%	No.	%
Educational Attainment						
<High School	4951782	67.3	608639	64.7	26137	66.7
High School or some college	1783203	24.3	247103	26.3	10133	25.9
Bachelors Degree	339072	4.6	48024	5.1	1664	4.2
Advanced Degree	162122	2.2	24559	2.6	820	2.1
NA	117086	1.6	12091	1.3	441	1.1
Race						
Black	656027	8.9	34159	3.6	278	0.7
Other	27778	0.4	3296	0.4	43	0.1
White	6669460	90.7	902961	96.0	38874	99.2
Marital Status						
Married	7013184	95.4	905924	96.3	38102	97.2
Not married	340081	4.6	34492	3.7	1093	2.8
Homeownership						
Homeowner	1780906	24.2	249379	26.5	11553	29.5
Not Homeowner	5572359	75.8	691037	73.5	27642	70.5
Socioeconomic Status Indicator						
Sei 1-9	1293523	17.6	138209	14.7	5513	14.1
Sei 10-14	1170543	15.9	149673	15.9	7962	20.3
Sei 15-25	1862967	25.3	246484	26.2	10028	25.6
Sei 26+	2776321	37.8	380226	40.4	14745	37.6
NA	249911	3.4	25824	2.7	947	2.4
Rural						
Rural	3183160	43.3	397739	42.3	19754	50.4
Urban	4170105	56.7	542677	57.7	19441	49.6

Crossover - Restricting to Exact Age



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