Revisiting the Black-White Mortality Crossover Paradox: Evidence from Large-scale, Linked U.S. Administrative Cohort Data

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About me

I combine formal demography and insights from the emerging field of computational data science to study questions in **population inequality**

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Two lines of research

1. Mortality dynamics and disparities
   - Homeownership and longevity (Breen 2024, *Demography*)
   - Stochasticity, inequality, and lifespan (Breen and Seltzer 2026, *PDR*)
   - Racial disparities—Black-White mortality crossover paradox **(today)**
2. Computational social science
   - Network-based method for estimating mortality in humanitarian crises (Breen et al. 2025, *AJE*)
   - Small area estimation of digital inequality (Breen et al. 2025, *PNAS*)

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

Elizabeth Wrigley-Field | Authors Info & Affiliations

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August 24, 2020 | 117 (36) 21854-21856 | https://doi.org/10.1073/pnas.2014750117

71,137 | 70 PDF/EPUB

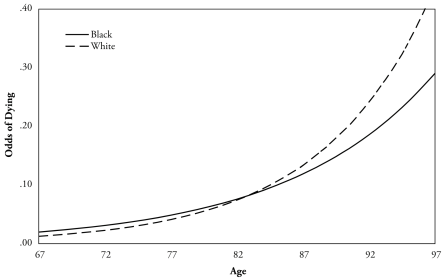
PNAS. Wrigley-Field 2020.

Paradox: Black-White mortality crossover

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

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- Yet — among oldest-old, Black mortality is lower than White mortality (!)
- Black-White mortality crossover is a well-studied demographic **paradox**



Dupre 2006. *Demography.*

Why understanding Black-White crossover is important

1. Fundamental to our understanding of mortality **inequality** over the life course

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2. Oldest-old is fastest growing age segment, potential social policy implications

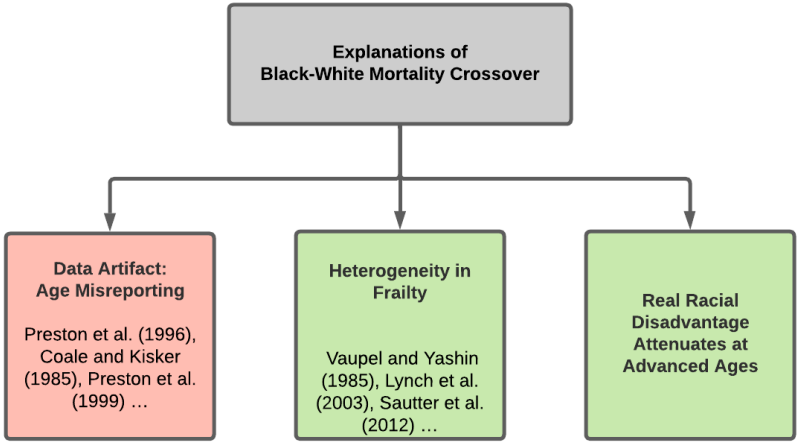
Why understanding Black-White crossover is important

1. Fundamental to our understanding of mortality **inequality** over the life course
2. Oldest-old is fastest growing age segment, potential social policy implications
3. Implications for theories of cumulative disadvantage and weathering (Diprete, 2006; Geronimus, 2023)

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...

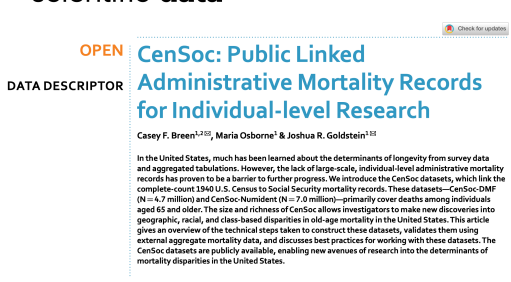


Research questions

1. Is the Black-White mortality crossover a **data artifact**?
2. Does **heterogeneity in frailty** explain the Black-White crossover? Is there really observable late-life mortality selection?

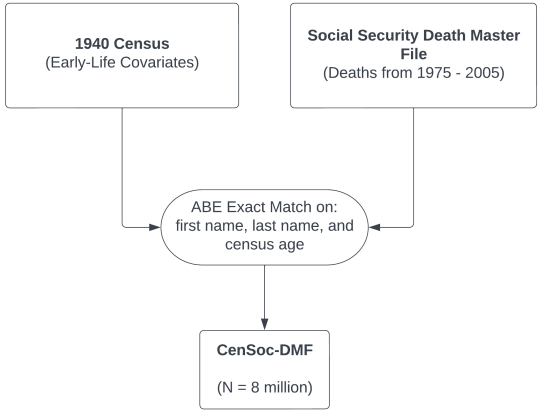
New Data Allows Us to Make Progress

- Data limitations have hampered efforts to explain crossover
- Comparative advantage:
  1. Massive sample (1M deaths)
  2. Cohorts
  3. Covariates

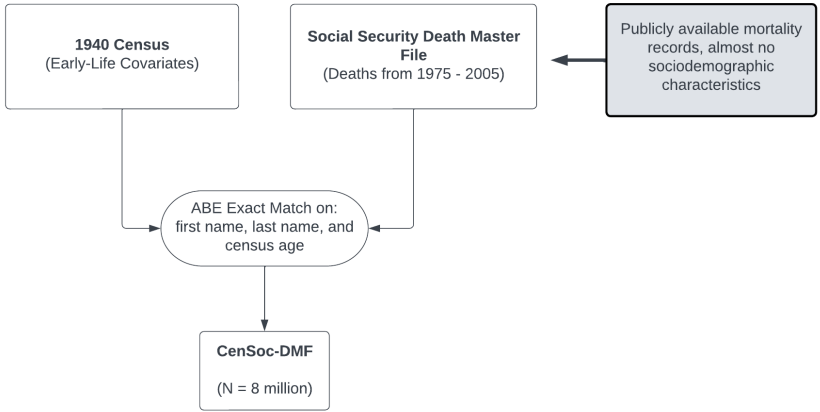


Breen, Osborne, Goldstein 2023

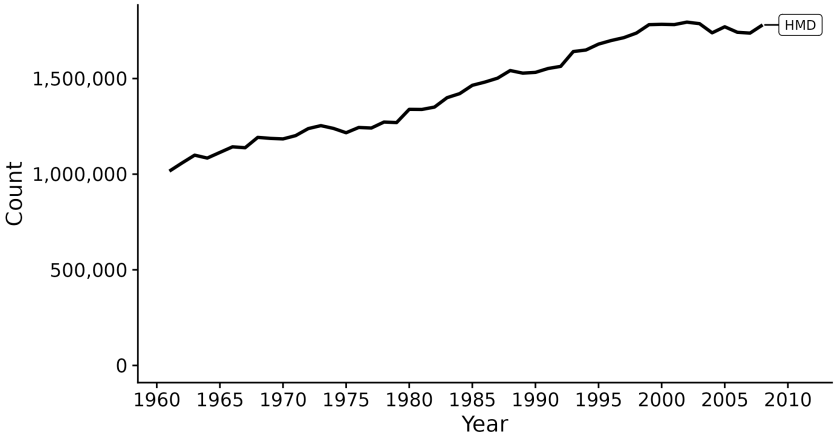
CenSoc-DMF: Linked IPUMS 1940 Census and mortality records



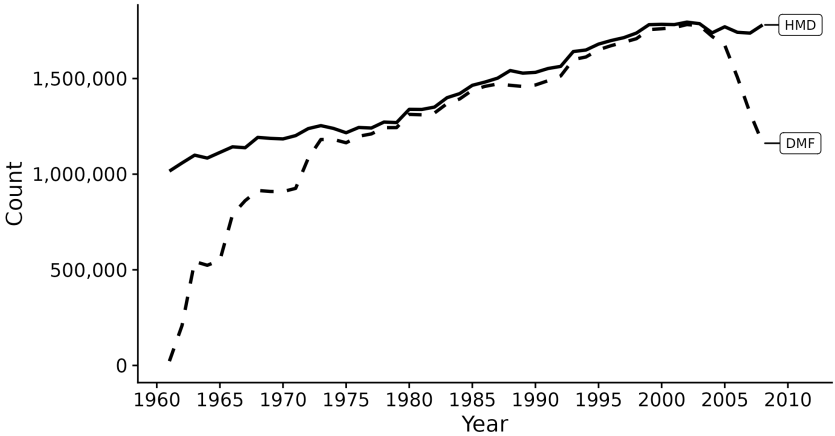
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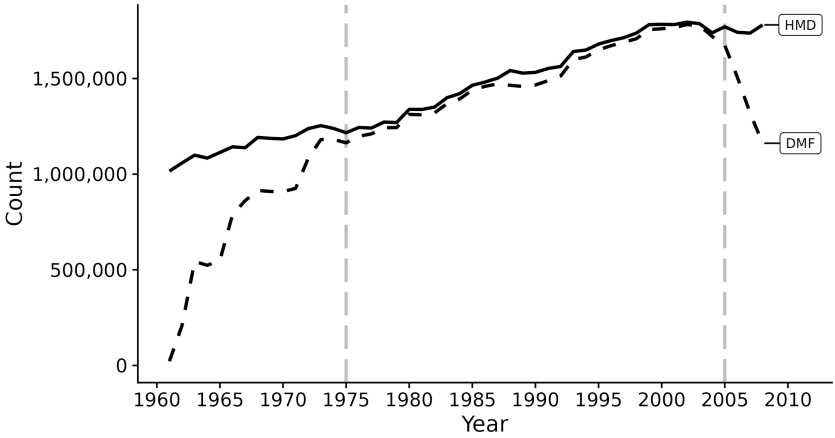
Death Master File (DMF) coverage (65+)



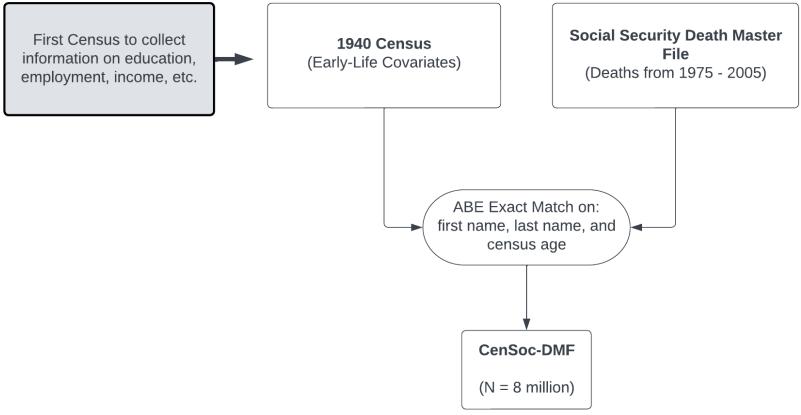
Death Master File (DMF) coverage (65+)



97% death coverage 1975-2005 (65+)



CenSoc-DMF: Linked 1940 Census and mortality records



1940 Census

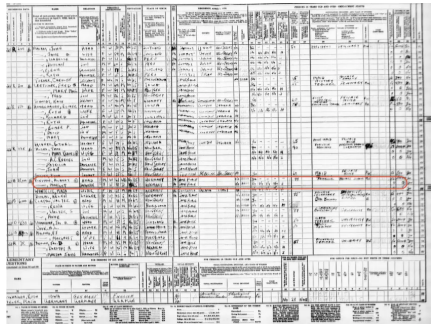
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- First decennial census to include question on educational attainment, wage and salary income, and detailed questions on employment

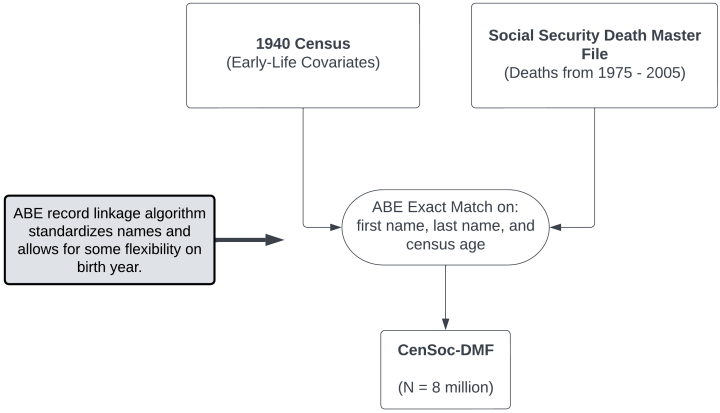
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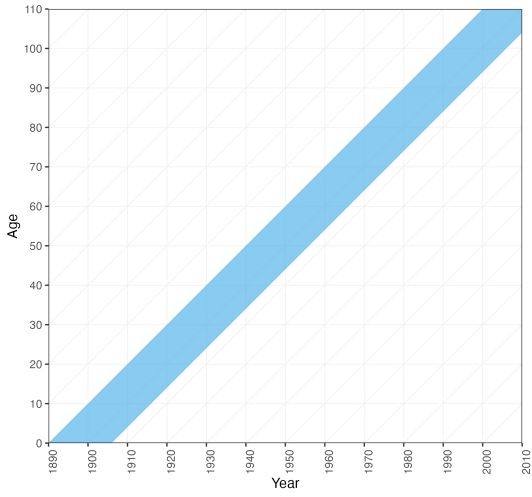
1940 Census Form

CenSoc-DMF: Linked census and mortality records



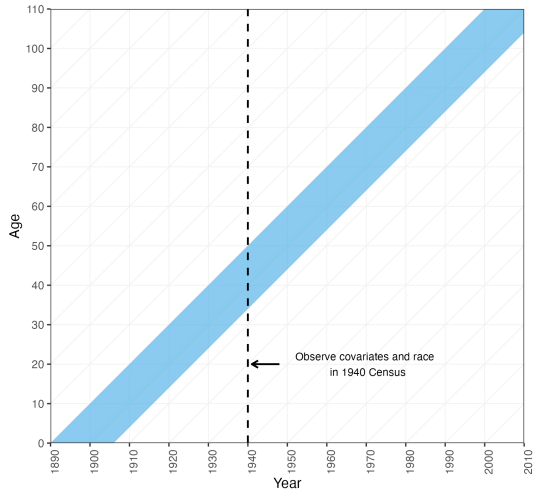
Analytic Sample

- Birth cohorts of 1890-1905
  - $N = 900,000$ deaths
- Sample restrictions
  - Men only
  - U.S. born



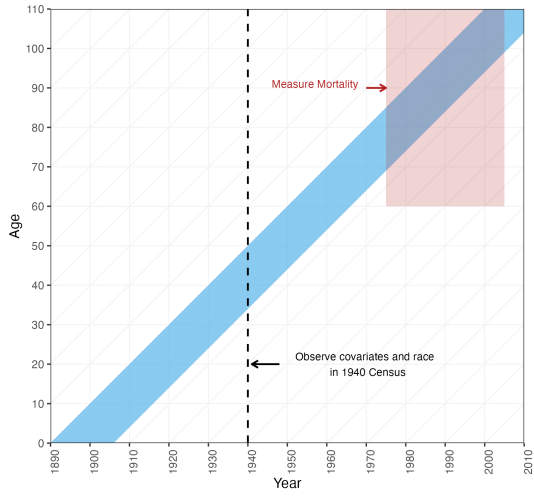
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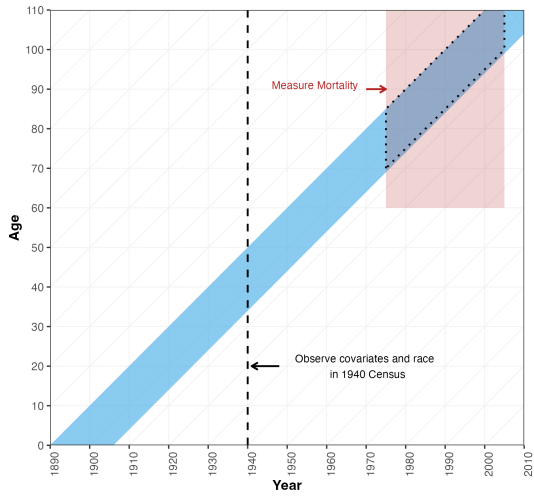
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Birth cohorts of 1890-1905: extinct cohort method

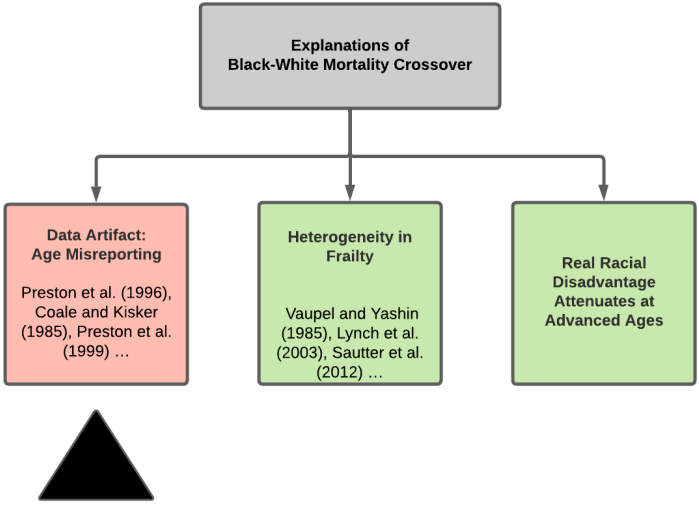
- Assumes that all members of the cohort have died by a certain year
- Uses recorded deaths over time to reconstruct the cohort's survival pattern

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

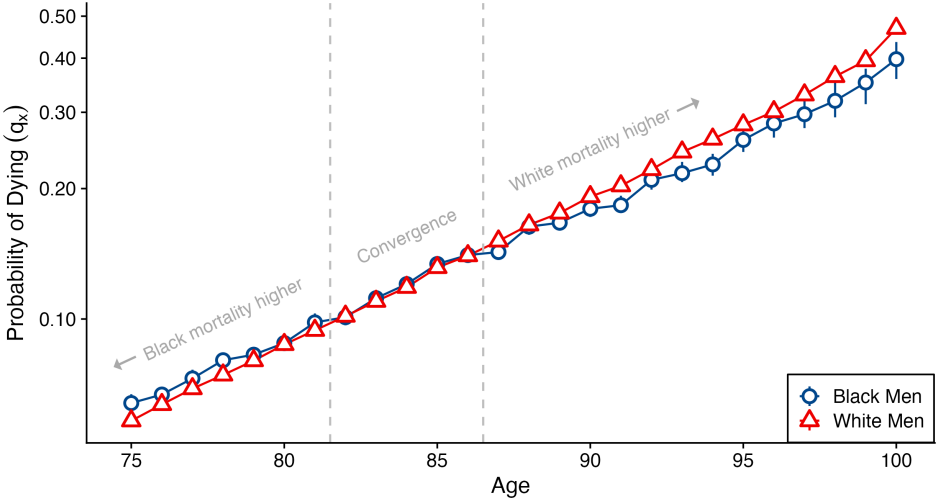
where:

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

Question 1: Is the crossover a data artifact?



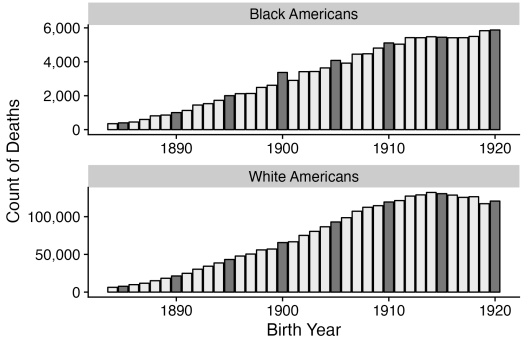
Black-White crossover (extinct cohort method)



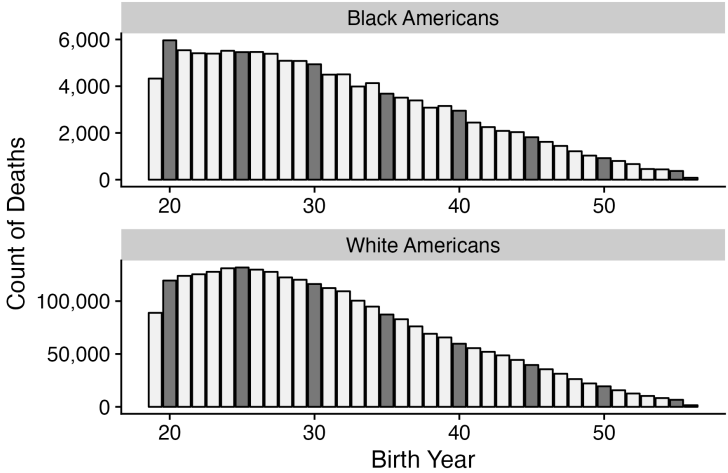
Question 1: Is the crossover a data artifact?

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

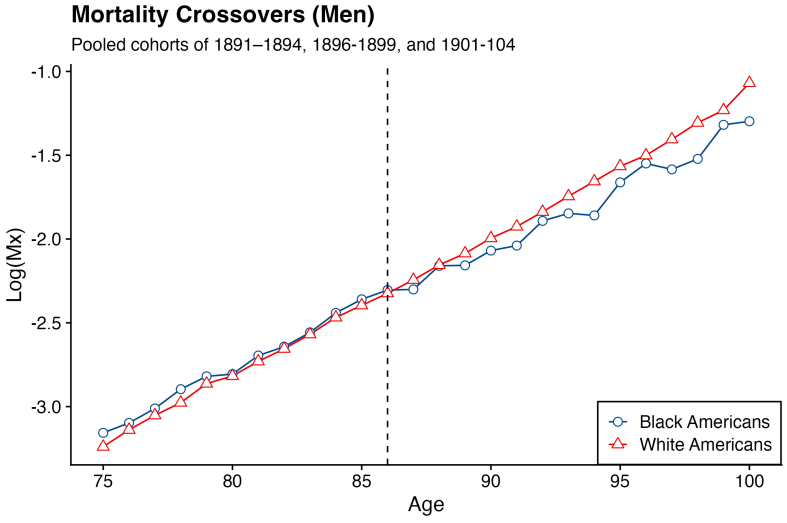
1. Minimal age heaping on birth year...
2. Date of death gets reported immediately (no heaping)
3. Institutional incentive: Social Security wants to accurately track birth date
4. Linkage requires close match on year of birth and Census age



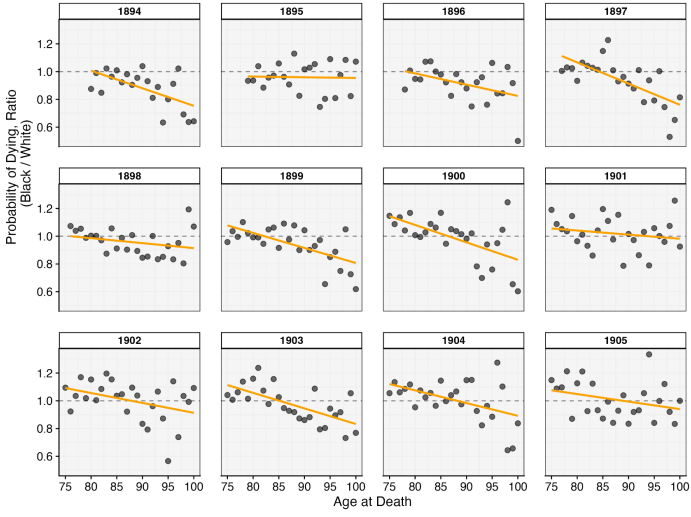
No age heaping in 1940 Census



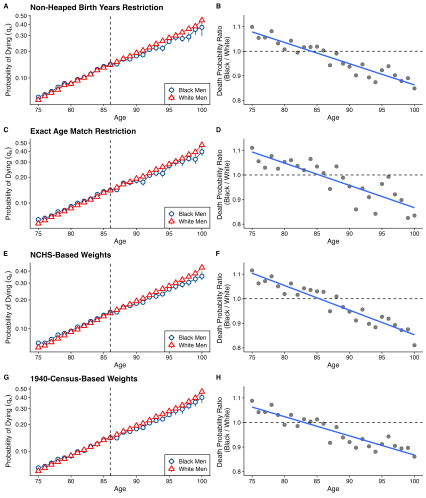
Black-white crossover (extinct cohort method)



Black-white crossover (extinct cohort method)



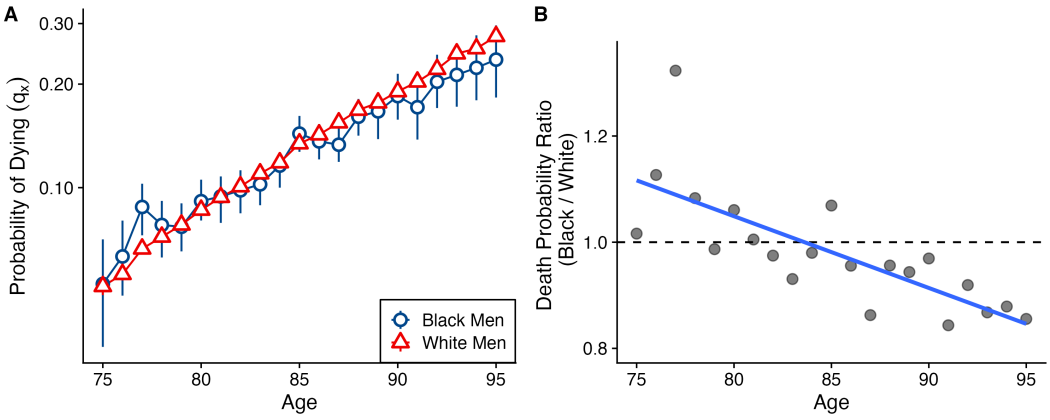
Black-white crossover robustness (extinct cohort method)



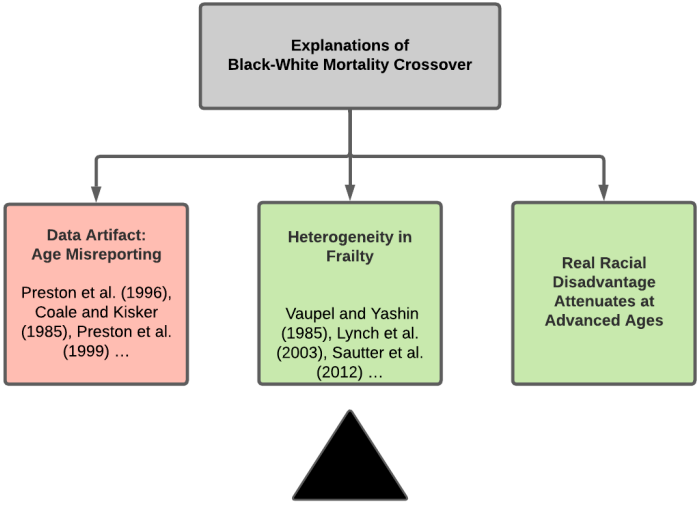
Robustness checks

- Drop heaped years
- Exact match on birth year
- Re-weight on 1940 Census characteristics
- Alternative mortality estimation methods

Crossover - 1900 Census Robustness Check

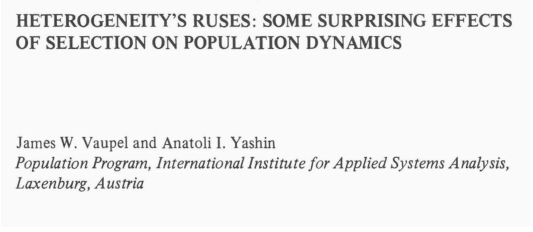


Question 2: Is the crossover driven by heterogeneity in frailty?



Heterogeneity in frailty – overview of approach

- First, how much **mortality selection** do we actually observe...?
- Second, does stratifying on heterogeneity uncross the crossover?
- **Frailty:** an individual's susceptibility to death
  - (Lack of) Wealth, education, environmental, behavioral, biological, etc.



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

Unpacking the black box of frailty...

- Lots of theorizing on frailty — but less empirical evidence due to data limitations
- Data-driven investigation of components of frailty that we can observe: sociodemographic characteristics

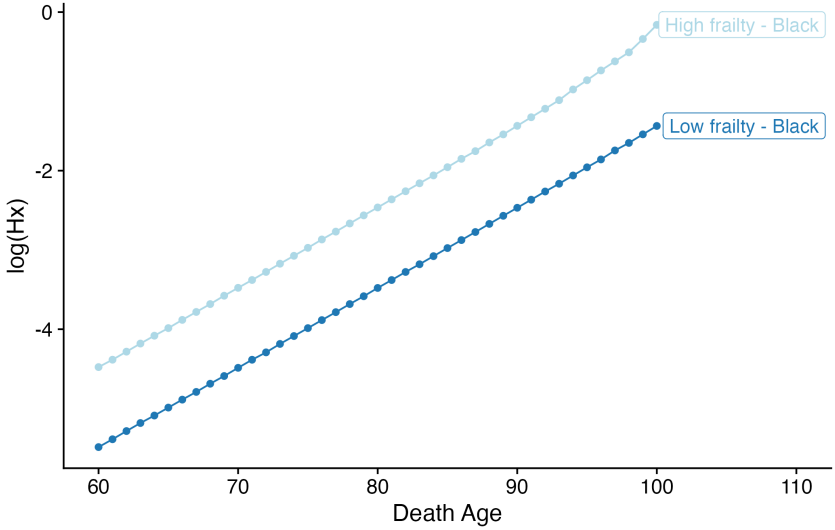
The theory of heterogeneity in frailty

- To get a crossover, higher initial mortality population must have **higher variance** in frailty

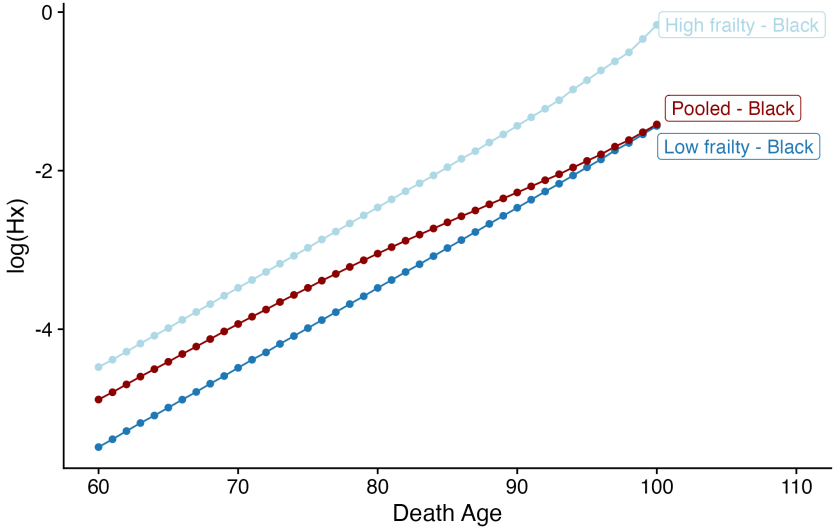
The theory of heterogeneity in frailty

- 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

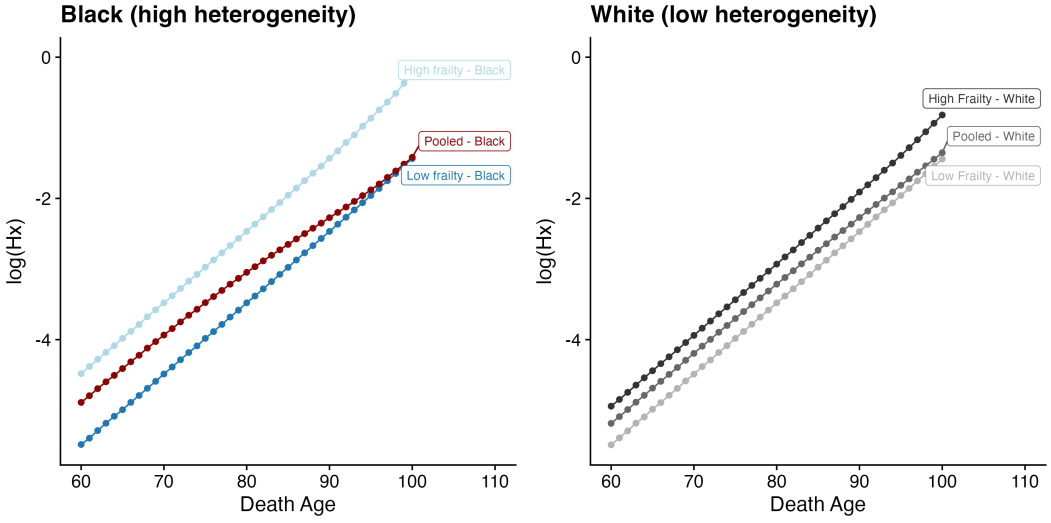
Heterogeneity in frailty (stylized example)



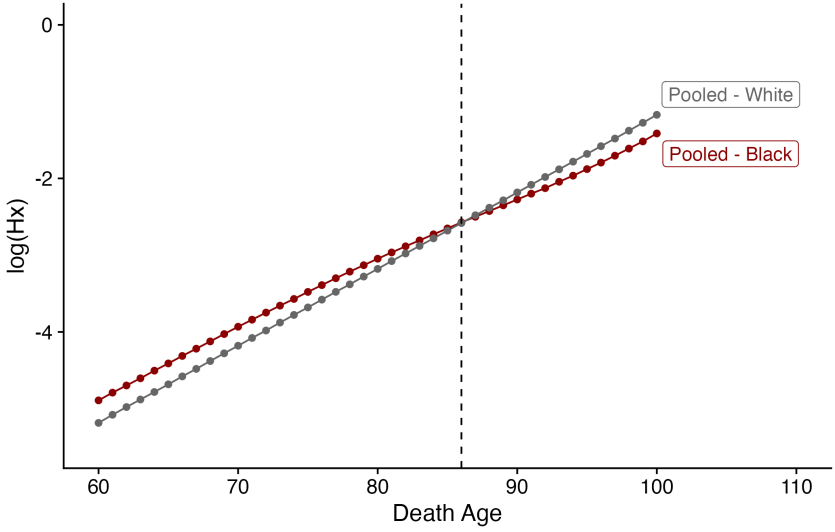
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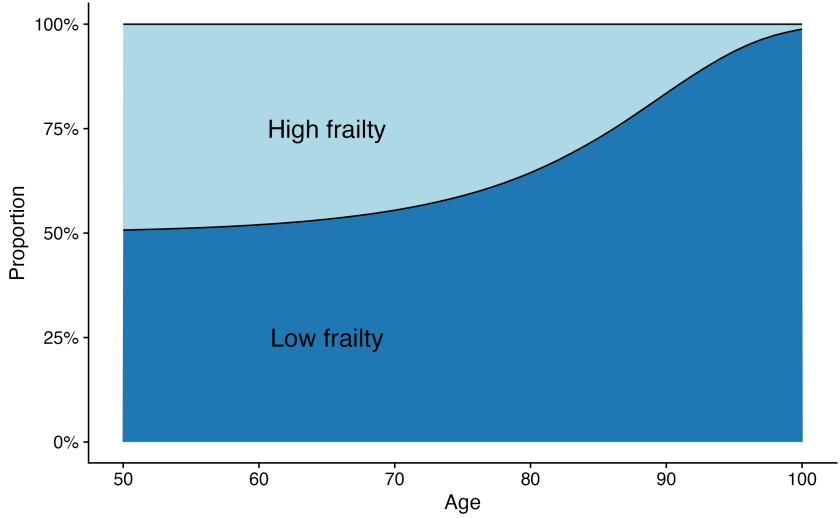
Heterogeneity in frailty (stylized example)



Heterogeneity in frailty (stylized example)



Very dramatic shift in composition of survivors...



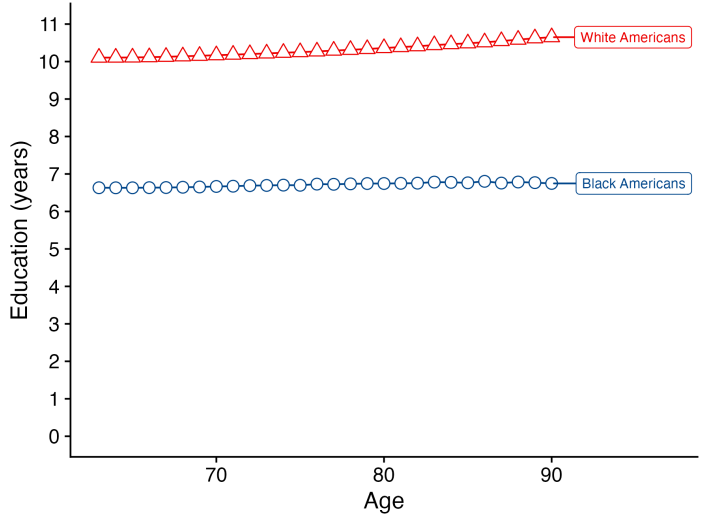
Empirical testing

- In order for the theory of frailty to explain the Black-White crossover, there must be stronger frailty selection over the life course for Black Americans than for White Americans

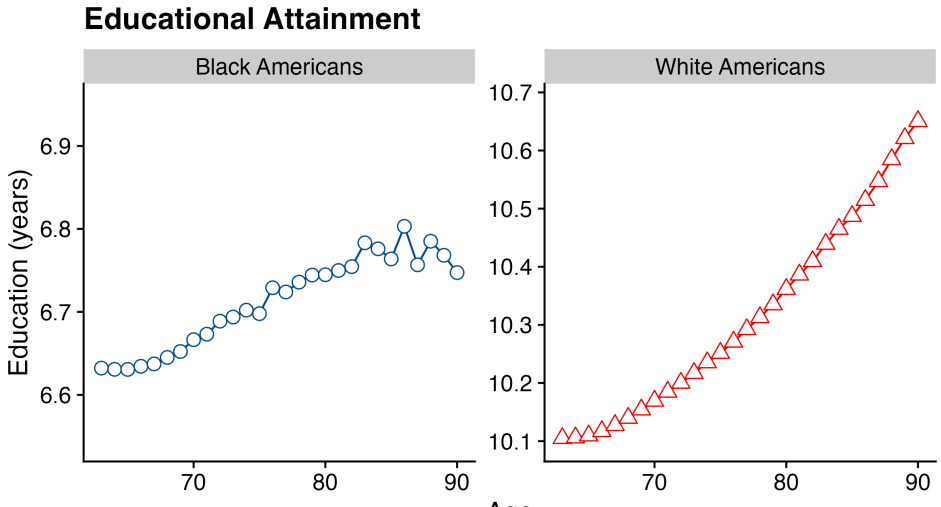
Empirical testing

- In order for the theory of frailty to explain the Black-White crossover, there must be stronger frailty selection over the life course for Black Americans than for White Americans
- We don't observe frailty but we observe characteristics that comprise part of frailty
  - Educational attainment
  - Occupation and income
  - Wealth

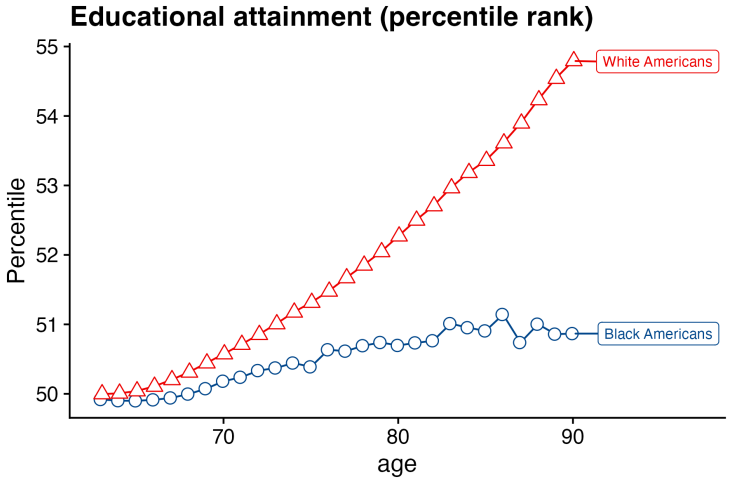
Changing educational composition of survivors



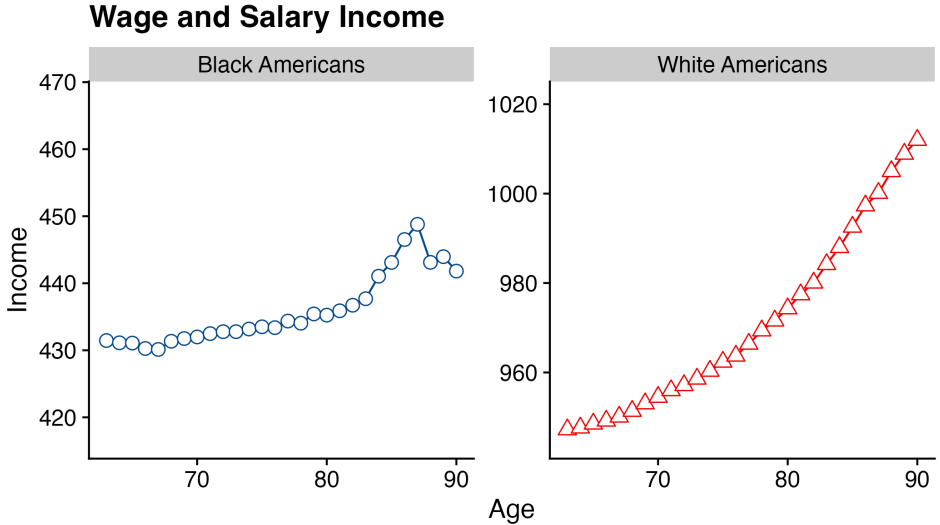
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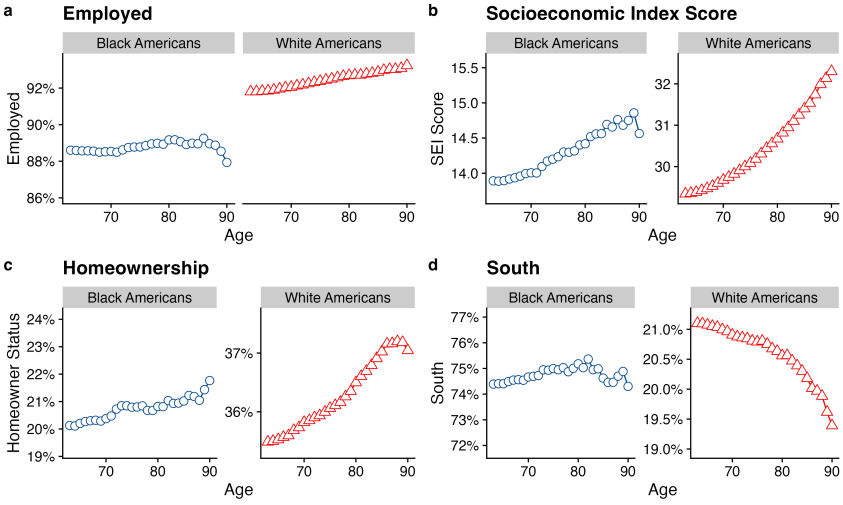
Changing educational composition of survivors (percentile)



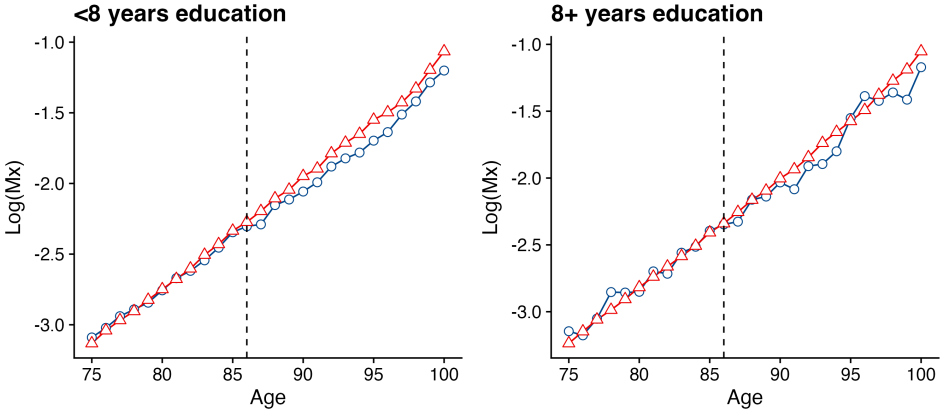
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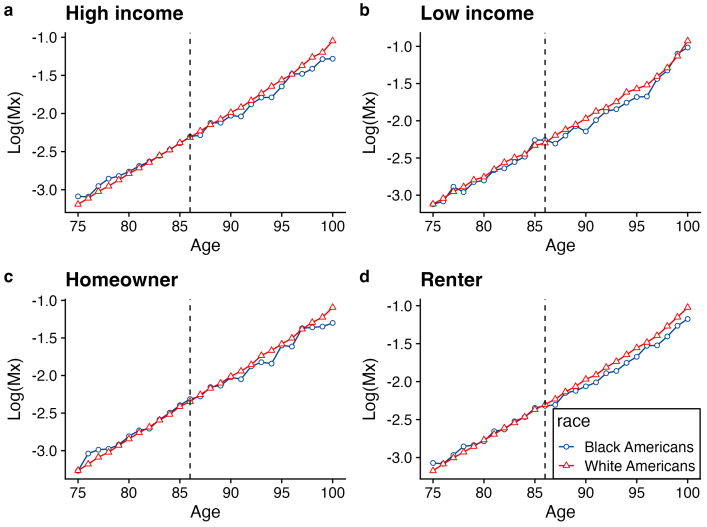
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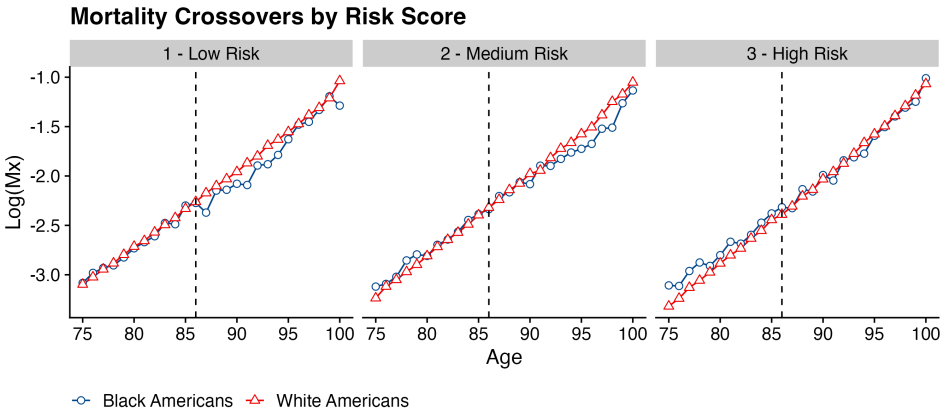
Stratifying by dimensions of frailty



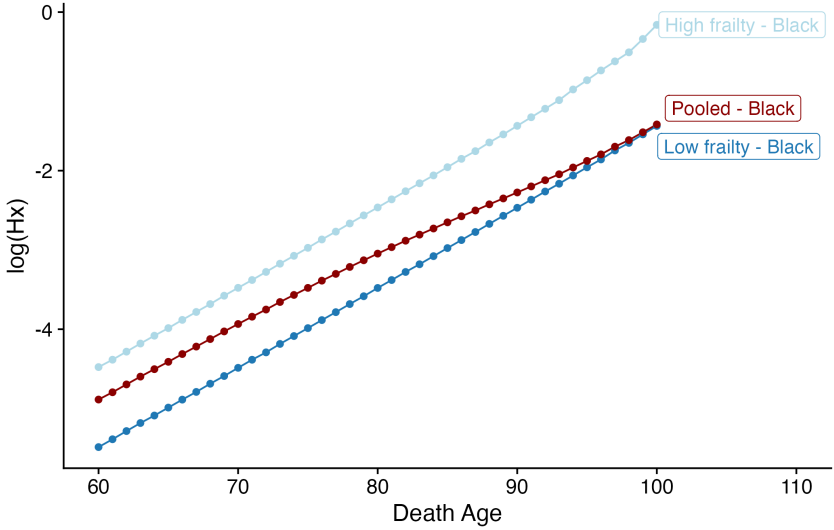
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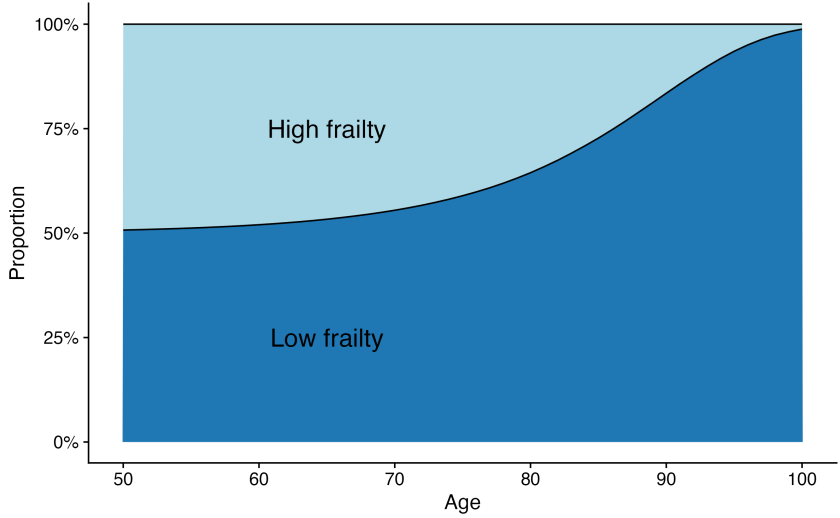
Stratifying on risk score



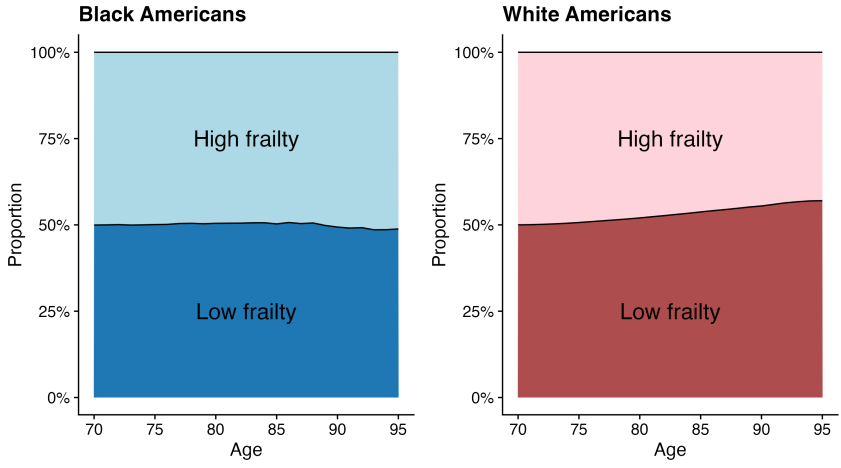
How much selection would we need? (Simulation)



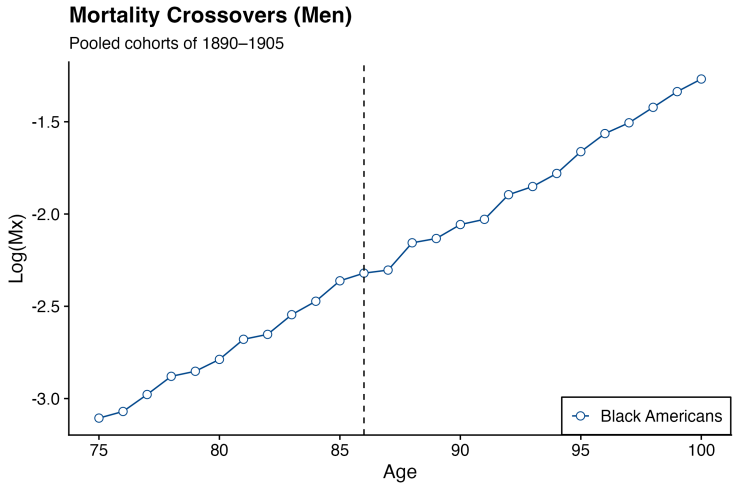
How much selection would we need for Blacks? (Simulation)



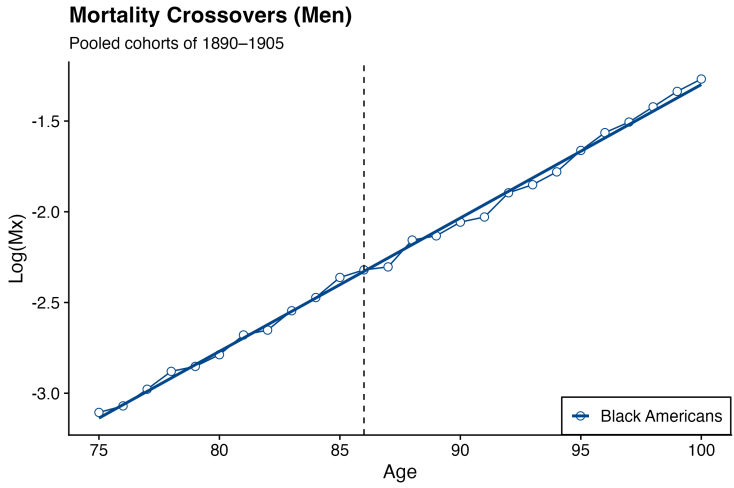
How much selection do we actually observe? Very little



Visible mortality deceleration from selection? (Bend in curve?)



No evidence of deceleration...



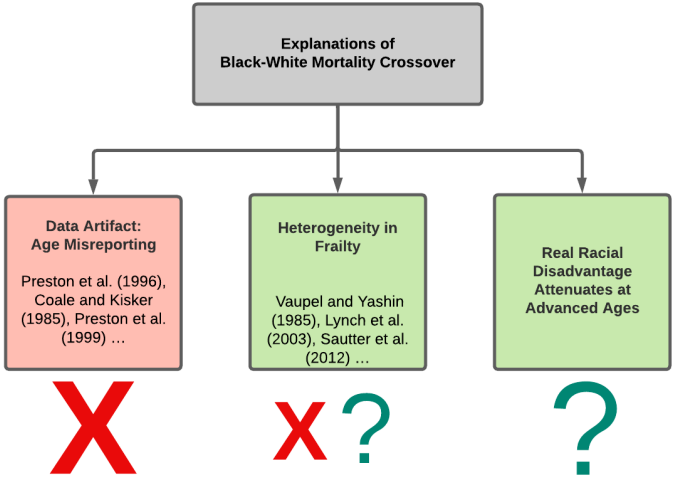
No support for heterogeneity in frailty explanation

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

Revisiting explanations...



Perhaps adaptive resilience

- **Resilience**
  - Lifelong exposure to adversity (racism, economic hardship, discrimination) may cultivate adaptive coping mechanisms
  - Black Americans have higher levels of self-esteem and religiosity than white Americans (**Louie 2024**), better mental health (**Erving 2021**) and subjective survival expectations (**Bernstein and Sasson 2021**)
- **Supportive Social Structures**
  - Older Black adults are more deeply embedded in extended family systems + live closer to kin (**Springer, Crowder, et al. 2023**)
  - More embedded networks provide caregiving, daily help, companionship, protection from loneliness (**Durkheim 1897, Cornwell and Qu, 2024, Umberson et al. 2010**)

Conclusions

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Conclusions

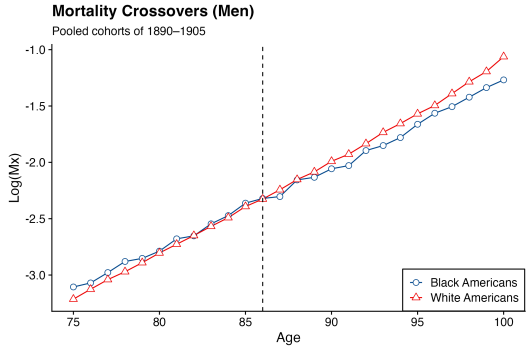
- Black-White Crossover is real — *not* ***data artifact***
- No support for **heterogeneity in frailty** explanation
  - Not educational attainment, not income, not wealth, not risk score
  - However, other unobserved dimensions of heterogeneity might be responsible (biomarkers, self-rated health)
- Attenuation of disadvantage from adaptive resilience: **Intriguing**, but need more theoretical and empirical work
- New explanations are needed (!)

Thank you — questions?

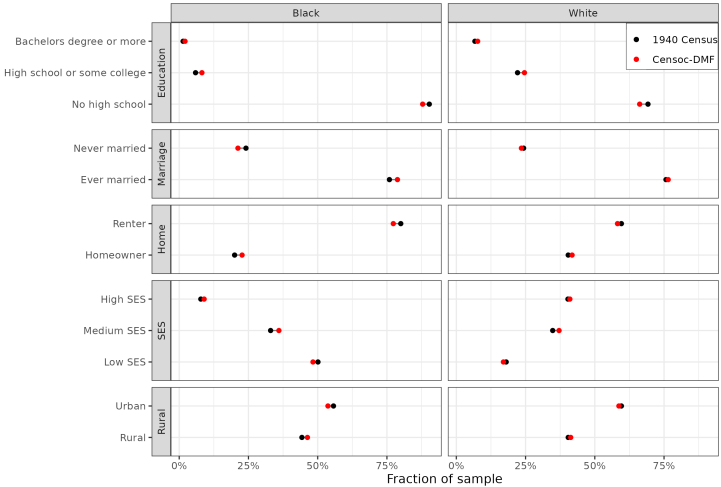
Data: CenSoc.Berkeley.edu

Funding: R01AG058940, R01AG076830

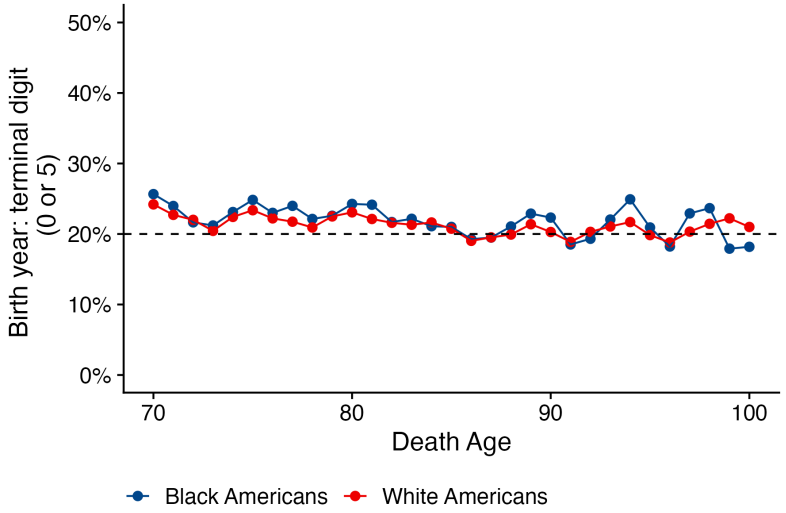
Contact: ✉ casey.breen@austin.utexas.edu



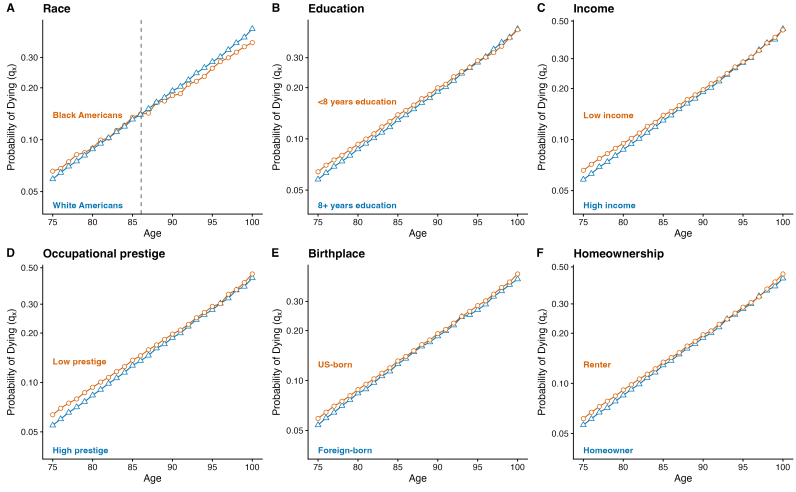
Representativeness



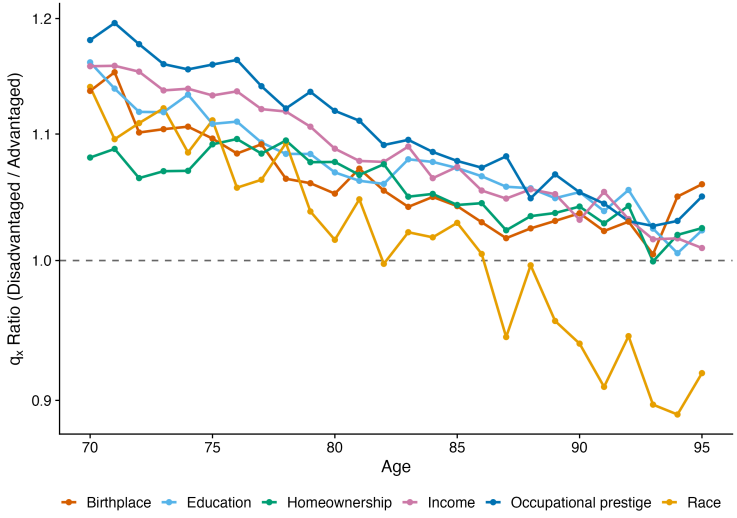
Age heaping


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

Mortality crossovers: other dimensions



Uniqueness of Black-White Crossover



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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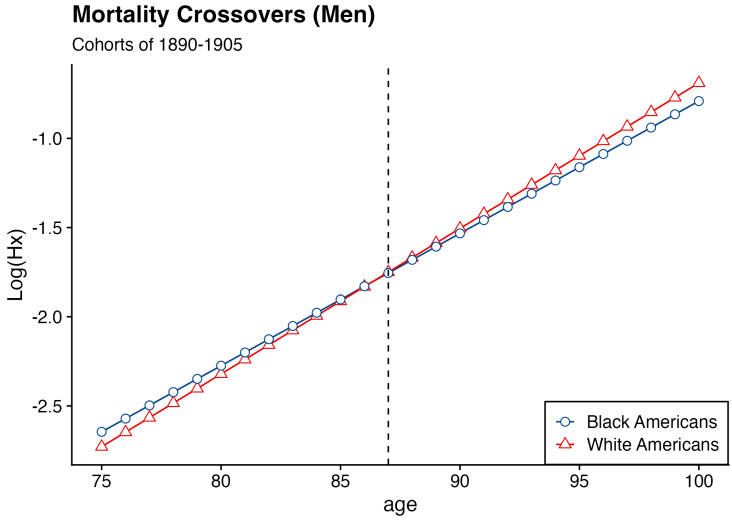
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Birth cohorts of 1906-1915: Gompertz Hazard Model

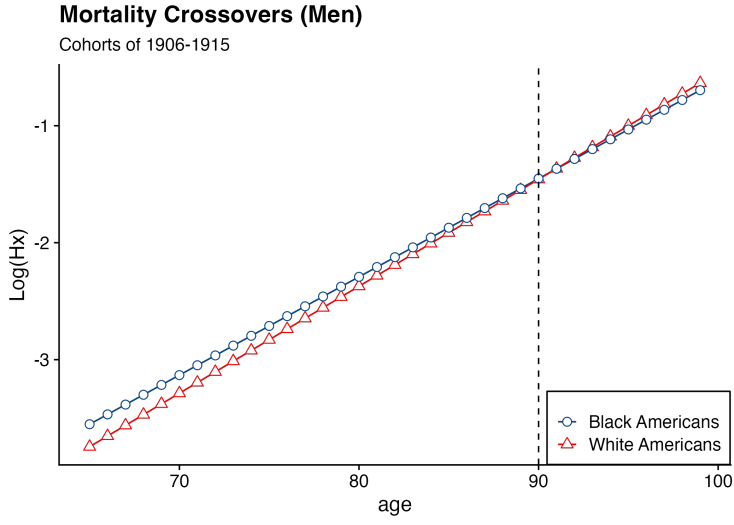
$$h(x) = \mathbf{a}e^{\mathbf{b}x} \tag{2}$$

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

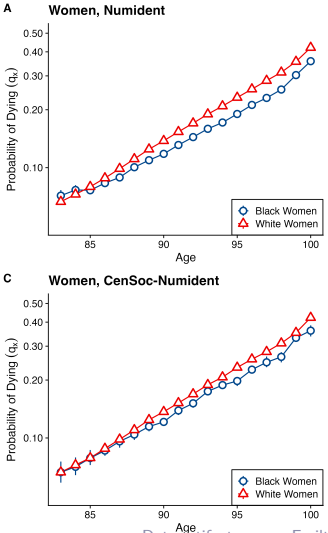
Black-white crossover (Gompertz Hazard Model)



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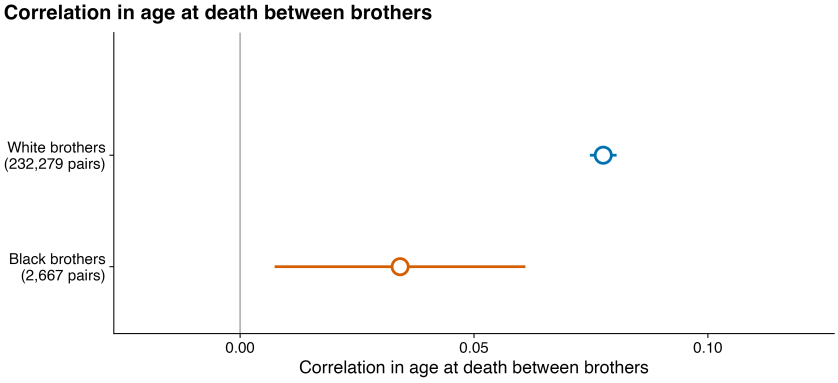


Crossover for women (Numident, 1988–2005)

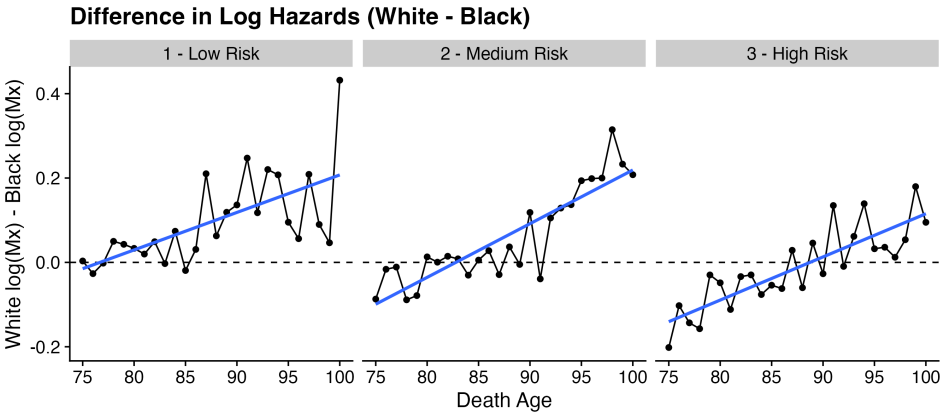


- Numident has a more narrow mortality estimation window
- However, women can be linked because we have parents' names
- Crossover for women around age 85

Brother correlation in lifespan



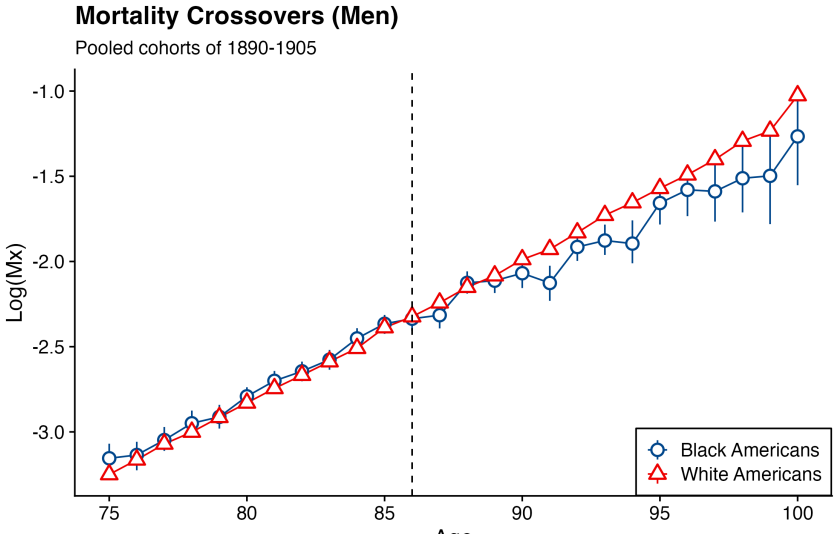
Stratifying on risk score



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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